Appendix A

Revised Development of Risk-Based Concentrations for Arsenic in Soil Memorandum
CRA, Revision 3, November 13, 2014

CONESTOGA-ROVERS & ASSOCIATES

651 Colby Drive, Waterloo, Ontario, Canada N2V 1C2
Telephone: (519) 884-0510 Fax: (519) 884-0525
www.CRAworld.com

MEMORANDUM

TO:	Greg Carli/Jeni Quigley	REF. NO.:	056394
FROM:	April Gowing/Vincent Nero/ds/16 JQ for	DATE:	June 26, 2013
		REVISION 1	December 20, 2013
		REVISION 2	August 7, 2014
		REVISION 3	November 13, 2014

RE: Revised Development of Risk-Based Concentrations for Arsenic and PCBs in Soil
Former Plainwell, Inc. Mill Property
Plainwell, Michigan

1.0 Introduction

Conestoga-Rovers & Associates (CRA) has prepared this memorandum to document the development of risk-based concentrations (RBCs) that are protective of human health direct contact exposure to arsenic and polychlorinated biphenyls (PCBs) in soil located at the former Plainwell, Inc. Mill Property in Plainwell, Michigan (Site). The development of the RBCs generally followed the approved Human Health Risk Assessment (HHRA) portion of the Remedial Investigation Report (Revision 2) (RI Report), which indicated that direct contact exposure to arsenic and PCBs in soil were the major contributors to unacceptable risks/hazards. Therefore, any actions that are required to mitigate potential exposure to the arsenic and PCB impacts would need to address the unacceptable risks/hazards associated with direct contact exposure with soil. The RI Report (Revision 2) was submitted to United States Environmental Protection Agency (U.S. EPA) on February 4, 2013 and was approved by U.S. EPA on February 26, 2013.

The development of the RBCs for arsenic is presented in Section 2.0 and the development of the RBCs for PCBs is presented in Section 3.0

2.0 Development of Risk-Based Concentrations for Arsenic in Soil

RBCs were developed for arsenic in soil that are protective of trespassers, recreational users, residents, commercial workers, utility workers, and construction workers. These same receptors were evaluated in the RI Report. Two RBCs were initially developed: one protective of carcinogenic health impacts and a second protective of non-carcinogenic health impacts. The RBC for each receptor was determined to be the lower value between carcinogenic and non-carcinogenic health impacts.

The equations used to develop the RBCs are presented in Section 2.1. Section 2.2 presents the receptor-specific exposure assumptions applied in the development of the RBCs. Section 2.3 presents the human health toxicity values applied for arsenic. The equations, exposure assumptions, and toxicity values utilized in the derivation of the RBCs are the same as those used in the forward risk and hazard calculations, as summarized in the RI Report, unless otherwise noted below. Section 2.4 presents the calculated RBCs for each receptor.

2.1 RBC Equations

RBCs have been developed for a trespasser, recreational user, resident, commercial worker, utility worker, and construction worker exposure to arsenic in soil. The soil RBCs were developed for incidental ingestion, dermal contact, and inhalation routes of exposure using the following equations:

Recreational User/Resident

Carcinogenic Endpoint:

Carcinogenic RBCs were developed to be protective of the child and adult recreational user/resident exposure. Therefore, exposure for each life stage was combined in the following equation:

$$RBC_{soil} = \frac{TR \times AT_c}{\begin{array}{c}(((CSF \times IR_c \times ABS_o \times CF \times EFa \times ED_c)/BW_c)) + ((CSF \times SA_c \times AF_c \times ABS_d \times CF \times EFb \times ED_c)/BW_c)) + ((URF \times FT \times EFa \times ED_c \times (1/PEF))) + \\ ((CSF \times IR_a \times ABS_o \times CF \times EFa \times ED_a)/BW_a)) + ((CSF \times SA_a \times AF_a \times ABS_d \times CF \times EFb \times ED_a)/BW_a)) + ((URF \times FT \times EFa \times ED_a \times (1/PEF)))\end{array}}$$

Non-Carcinogenic Endpoint:

For the determination of the non-carcinogenic RBCs, the exposure for the child recreational user/resident, the most sensitive life stage, was applied as a conservative method using the following equation:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED_c \times [((1/RfD) \times IR_c \times ABS_o \times CF \times EFa)/BW_c) + ((1/RfD) \times SA_c \times AF_c \times ABS_d \times CF \times EFb)/BW_c) + ((1/RfC) \times EFa \times FT \times (1/(PEF))]}$$

Where:

- ***RBC_{soil}*** = Risk-based concentration in soil based on ingestion, dermal contact, and inhalation exposure (mg/kg)
- ***TR*** = Target Cancer Risk
- ***THQ*** = Target Hazard Quotient
- ***BW_c*** = Body Weight - child (kg)
- ***BW_a*** = Body Weight - adult (kg)
- ***ATc*** = Averaging Time - carcinogen
- ***ATnc*** = Averaging Time - non-carcinogen - child (days)
- ***CSF*** = Cancer Slope Factor – oral/dermal - chemical-specific $(mg/kg/day)^{-1}$
- ***URF*** = Unit Risk Factor - inhalation - chemical-specific $(mg/m^3)^{-1}$
- ***RfD*** = Reference Dose – oral/dermal - chemical-specific (mg/kg/day)

RfC = Reference Concentration - inhalation - chemical-specific (mg/m^3)
ABS_o = Absorption Factor - oral - chemical-specific (%/100)
ABS_d = Absorption Factor - dermal - chemical-specific (%/100)
IR_c = Ingestion Rate - child (mg/day)
IR_a = Ingestion Rate - adult (mg/day)
CF = Conversion Factor (1.0×10^{-6} kg/mg)
SA_c = Surface Area Exposed - child (cm^2/day)
SA_a = Surface Area Exposed - adult (cm^2/day)
AF_c = Adherence Factor - child (mg/cm^2)
AF_a = Adherence Factor - adult (mg/cm^2)
FT = Fraction Time Exposed (hours/24 hours)
EFa = Exposure Frequency (days/year) – ingestion/inhalation
EFb = Exposure Frequency (days/year) – dermal
ED_c = Exposure Duration - child (years)
ED_a = Exposure Duration - adult (years)
PEF = Particulate Emission Factor - inhalation (m^3/kg)

<u>Trespasser/Commercial Worker/ Utility Worker/Construction Worker</u>

Carcinogenic Endpoint:

$$RBC_{soil} = \frac{TR \times AT_c}{ED \times [((CSF \times IR \times CF \times ABS_o \times EFa)/BW) + ((CSF \times SA \times AF \times CF \times ABS_d \times EFb)/BW) + ((URF \times FT \times EFa \times (1/PEF))]}$$

Non-Carcinogenic Endpoint:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED \times [((1/RfD) \times IR \times CF \times ABS_o \times EFa)/BW) + ((1/RfD) \times SA \times AF \times CF \times ABS_d \times EFb)/BW) + ((1/RfC) \times FT \times EFa \times (1/PEF))]}$$

Where:

RBC_{soil} = Risk-based concentration in soil based on ingestion, dermal contact, and inhalation exposure (µg/g)
TR = Target Cancer Risk
THQ = Target Hazard Quotient
BW = Body Weight (kg)
ATc = Averaging Time - carcinogen
ATnc = Averaging Time - non-carcinogen
CSF = Cancer Slope Factor – oral/dermal - chemical-specific $(mg/kg/day)^{-1}$
URF = Unit Risk Factor – inhalation - chemical-specific $(mg/m^3)^{-1}$
RfD = Reference Dose – oral/dermal - chemical-specific (mg/kg/day)
RfC = Reference Concentration – inhalation – chemical-specific (mg/m^3)
ABS_o = Absorption Factor - oral - chemical-specific (%/100)

ABS_d	=	Absorption Factor - dermal - chemical-specific (%/100)
IR	=	Ingestion Rate (mg/day)
CF	=	Conversion Factor (1.0×10^{-6}kg/mg)
SA	=	Surface Area Exposed (cm^2/day)
AF	=	Adherence Factor (mg/cm^2)
FT	=	Fraction Time Exposed (hours/24 hours)
EFa	=	Exposure Frequency (days/year) – ingestion/inhalation
EFb	=	Exposure Frequency (days/year) – dermal
ED	=	Exposure Duration (years)
PEF	=	Particulate Emission Factor - inhalation (m^3/kg)

For utility and construction workers, the potential inhalation exposure to arsenic in soil particulates migrating to ambient air as part of fugitive dust emissions was determined through the calculation of a particulate emission factor (PEF), which was used to estimate ambient air concentrations based on soil concentrations. The PEF is Site-specific and was calculated using the approach presented in U.S. EPA (2002)[1]. The equations and inputs for the calculated PEF values for soil are presented in Tables 1 and 2 for the utility worker and construction worker, respectively.

2.2 Receptor-Specific Exposure Assumptions

With the exception of the oral absorption factor and exposure frequency, all other exposure assumptions that were applied in the equations presented above for the derivation of the RBCs were obtained from the RI Report for each of the receptors indicated above and thus are not reproduced here. These exposure assumptions are primarily U.S. EPA default exposure assumptions. A detailed discussion of receptor-specific exposure assumptions applied is presented in the RI Report. The assumptions applied for the oral absorption factor and exposure frequency in the derivation of the RBCs is presented below.

Oral Absorption Factor

Absorption factors are applied in the development of the RBCs as a measure of the bioavailable fraction that enters the human body as a result of oral, dermal, and inhalation exposure. An oral absorption factor of 100 percent, or 1 was applied in the RI Report. More recent information has been published that indicates that this absorption factor is highly conservative and significantly overestimated risks/hazards. The current default oral absorption factor is based on the assumption that the bioavailability of arsenic in soil is the same as the bioavailability in the exposure medium used to derive the toxicity value (water in the case of arsenic), and; therefore, relative bioavailability of arsenic is assumed to be 100 percent (i.e., oral absorption factor of 1). However, studies have shown that the bioavailability of arsenic in soil is less than that of arsenic in water. U.S. EPA have conducted a review of these studies, and based on the results have recommended a relative bioavailability factor of 60 percent or 0.6 for arsenic in soil (U.S. EPA, 2012)[2]. Therefore, an oral absorption factor of 0.6 was applied in the development of the RBCs for arsenic in soil.

[1] U.S. EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.
[2] U.S. EPA, 2012. Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil, OSWER 9200.1-113, December 2012.

Exposure Frequency

Generic screening criteria are developed in a conservative manner, based on an assumed exposure frequency of 7 days per week for 50 weeks per year, or 350 days per year (2 weeks for vacation is assumed) for residential land use and an assumed exposure frequency of 5 days per week for 50 weeks per year, or 250 days per year (2 weeks for vacation is assumed) for commercial land use (U.S. EPA, 2004)[3]. In reality, the exposure frequency to soils in residential and/or commercial settings is influenced by weather conditions.

Direct contact exposure to soil can be affected by weather conditions. For instance, it is expected that soils during the winter months are snow-covered and; therefore, unavailable for dermal contact. Based on this information, soil exposure frequency was based on consideration of local climate conditions, specifically, the number of days where the soil is not snow-covered (and the ground is not frozen), similar to the approach applied by the Michigan Department of Environment Quality (MDEQ) in the development of the Michigan Act 451, Part 201 (Part 201) Generic Cleanup Criteria (GCC)(MDEQ, 2013)[4]. This approach assumes that ingestion and inhalation exposure pathways would occur for a period of 350 days per year for a resident and 245 days per year (50 weeks per year x 5 days per week – 5 days per year for vacation/sick leave) for a commercial worker. For dermal exposure to soil, the MDEQ approach assumes that soils are snow-covered for a period of 4 months of the year (120 days per year) and during this period there is no dermal contact with soils. Therefore, dermal exposure pathways are assessed based on exposure frequencies of 245 days per year for a resident (365 days per year – 120 days per year snow cover) and 160 days per year for a commercial worker (365 days per year -120 days per year snow cover – 21 days per year vacation/sick leave x 5/7 days per week). The table below presents the exposure frequencies applied for the trespasser and recreational user using the same approach applied by the MDEQ for the resident and commercial worker.

Exposure Assumption	***Trespasser*** [(1)]	***Recreational User*** [(2)]
Exposure Frequency – Ingestion/Inhalation	50	70
Exposure Frequency - Dermal	34	48

Notes:

(1) The basis for the Exposure Frequency is the 50th percentile from Table 16-1, Recommended Values for Activity Factors – Time Outdoors (total) from U.S. EPA (2008)[5]. ***Ingestion/Inhalation***: the time spent outdoors for 11 to 16 year olds of 100 minutes/day out of a possible 365 days equates to 25 days (100 minutes/day x 365 days x 1 hour/60 minutes x 1 day/24 hours). The final exposure frequency is double the 50th percentile value, or 50 days. ***Dermal***: the time spent outdoors for 11 to 16 year olds of 100 minutes/day out of a possible 245 days (365 days per year – 120 days snow cover) equates to 17 days (100 minutes/day x 245 days x 1 hour/60 minutes x 1 day/24 hours). The final exposure frequency is double the 50th percentile value, or 34 days.

[3] U.S. EPA, 2004. U.S. EPA Risk Assessment Guidance for Superfund (RAGS): Volume 1 Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

[4] MDEQ, 2013. Operational Memoranda for the Remediation and Redevelopment Division: Part 201 Cleanup Criteria and Part 213 Risk Based Screening Levels. December 30, 2013.

[5] U.S. EPA, 2008. Child-Specific Exposure Factors Handbook, September 2008.

(2) The basis for the exposure frequency is the 50th percentile from Table 16-1, Recommended Values for Activity Factors – Time Outdoors (total) from U.S. EPA (2008). ***Ingestion/Inhalation***: the time spent outdoors for 6 to 12 month olds of 139 minutes/day out of a possible 365 days equates to 35 days (139 minutes/day x 365 days x 1 hour/60 minutes x 1 day/24 hours). The final exposure frequency is double the 50th percentile value, or 70 days. ***Dermal***: the time spent outdoors for 6 to 12 month olds of 139 minutes/day out of a possible 245 days (365 days per year – 120 days snow cover) equates to 24 days (139 minutes/day x 245 days x 1 hour/60 minutes x 1 day/24 hours). The final exposure frequency is double the 50th percentile value, or 48 days. It is assumed that the adult will spend the same amount of time outdoors with their child.

The exposure frequencies for the utility worker and construction worker were unchanged from those applied in the RI Report, given the fact that utility worker and construction worker activities could occur any time during the year regardless of the weather.

2.3 Toxicity Values

The toxicity values that were applied in the equations presented above for the derivation of the RBCs are the same as those applied in the RI Report.

2.4 Summary of Risk-Based Concentrations for Arsenic

The anticipated future use scenarios based on the current redevelopment plan for the Site consists of the following 11 Redevelopment Areas:

- Residential Area 1
- Residential Area 2
- Residential Area 3
- Residential Area 4
- Waterfront Plaza
- Mixed Residential/Commercial Area 1
- Mixed Residential/Commercial Area 2
- Commercial Area 1
- Commercial Area 2
- Commercial Area 3
- Commercial Area 4

A RBC was selected for each area representing the minimum calculated RBC for all receptors (for the most sensitive receptor) that could potentially be present within that area. All potential receptors could be present at Residential Areas 1 through 4 and Mixed Residential/Commercial Areas 1 and 2. All potential receptors, except residents and recreational users could be present at Commercial Areas 1 through 4. All potential receptors, except residents, could be present at Waterfront Plaza.

The calculated RBCs for arsenic in soil are presented in the following tables:

Receptor	***Table Reference***
Trespasser	Table 3
Recreational User	Table 4
Resident	Table 5
Commercial Worker	Table 6
Utility Worker	Table 7
Construction Worker	Table 8

Table 9 presents a summary of the calculated RBCs for each receptor at target cancer risk levels of 10^{-4}, 10^{-5}, and 10^{-6}, respectively, and a target hazard quotient of 1.0.

The proposed RBCs for each area of redevelopment are presented in the table below. These RBCs are based on the most sensitive receptor that is present within these areas, and target cancer risk range of 10^{-6} to 10^{-4} and target hazard quotient of 1.0. It should be noted that the calculated arsenic RBCs based on a cancer risk of 10^{-5} and 10^{-6} are below the Part 201 GCC for arsenic based on direct contact (7.6 µg/g for residential land use and 37 µg/g for non-residential land use) and the calculated arsenic RBCs based on a cancer risk of 10^{-6} are below the Part 201 Statewide Default Background Level (SDBL) (5.8 µg/g).

Redevelopment Area	***Arsenic RBC (µg/g)***		
	Cancer Risk = 10^{-4} Hazard Quotient = 1	***Cancer Risk = 10^{-5} Hazard Quotient = 1***	***Cancer Risk = 10^{-6} Hazard Quotient = 1***
Residential Area 1	36	6.4	0.64
Residential Area 2	36	6.4	0.64
Residential Area 3	36	6.4	0.64
Residential Area 4	36	6.4	0.64
Waterfront Plaza	178	27	2.7
Mixed Residential/Commercial Area 1	36	6.4	0.64
Mixed Residential/Commercial Area 2	36	6.4	0.64
Commercial Area 1	267	27	2.7
Commercial Area 2	267	27	2.7
Commercial Area 3	267	27	2.7
Commercial Area 4	267	27	2.7

The sections below compare the surface soil and soil (surface and subsurface) exposure point concentrations (EPCs) to the RBCs calculated for arsenic at each cancer risk level. Those areas with EPCs greater than the RBCs will require further action (management or remediation) to ensure protection of human receptors from direct contact exposure to soil. Those areas with EPCs less than the RBCs will require no further action with respect to direct contact with soil. The EPC for each area is based on the 95 percent upper confidence limit (UCL) of the mean, which is calculated using U.S. EPA's ProUCL 5.0 statistical software. It should be noted that the EPCs calculated in the RI Report were based on a previous

version of ProUCL (Version 4.1) that was current at that time; however, subsequently U.S. EPA have published an updated version of ProUCL (as of September 2013), which was applied within this document. Given the low sample numbers available for Waterfront Plaza, soil samples collected adjacent to Waterfront Plaza and within Residential Areas 3 and 4 were combined to form the Waterfront Plaza soil dataset to permit evaluation of soil exposure within this Redevelopment Area.

2.1.1 Arsenic RBC (Cancer Risk = 10^{-4}; Hazard Quotient = 1)

The table below presents a comparison of the arsenic EPC to the calculated arsenic RBC for each redevelopment area. The calculated RBC is based on a cancer risk of 1 x 10^{-4} and hazard quotient of 1.

Redevelopment Area	***EPC (µg/g)***		***Arsenic RBC (Cancer Risk = 10^{-4} and Hazard Quotient = 1) (µg/g)***
	Surface Soil	***Soil (Surface and Subsurface)***	
Residential Area 1	7.382	10.21	36
Residential Area 2	8.751	8.7	36
Residential Area 3	11.16	13.05	36
Residential Area 4	9.391	12.3	36
Waterfront Plaza	69.28	18.13	178
Mixed Residential/Commercial Area 1	8.111	11.02	36
Mixed Residential/Commercial Area 2	19.31	**47.39**	36
Commercial Area 1	7.361	7.234	267
Commercial Area 2	9.947	13.33	267
Commercial Area 3	12.24	9.59	267
Commercial Area 4	19.38	16.68	267

Notes:
Bold and Shading: EPC exceeds the arsenic RBC

Based on the information presented in the above table, only one Redevelopment Area (Mixed Residential/Commercial Area 2) requires further action to mitigate potential exposure to arsenic through direct contact with soil. Using an iterative approach, specific soil sampling locations containing the highest concentrations of arsenic from this Redevelopment Area were removed from the soil dataset used to calculate the EPC until the EPC met the RBC. The results of this analysis are presented in the table below for Mixed Residential/Commercial Area 2.

Mixed Residential/Commercial Area 2				
Original EPC (µg/g)	*Soil Locations Removed*		*Revised EPC (µg/g)*	*Arsenic RBC (Cancer Risk = 10^{-4} and Hazard Quotient = 1) (µg/g)*
	Location	*Arsenic Concentration (µg/g)*		
Soil (Surface and Subsurface)				
47.39	SB-232 (6-8 ft BGS)	804	18.44	36

Notes:
ft BGS: feet below ground surface

As indicated in the above table, removal of one soil location reduced the arsenic surface and subsurface soil EPC from 47.39 to 18.44 µg/g, which is below the arsenic RBC based on a cancer risk of 10^{-4}.

2.1.2 Arsenic RBC (Cancer Risk = 10-5; Hazard Quotient = 1)

The table below presents a comparison of the arsenic EPC to the calculated arsenic RBC for each redevelopment area. The calculated RBC is based on a cancer risk of 1 x 10-5 and hazard quotient of 1.

Redevelopment Area	*EPC (µg/g)*		*Arsenic RBC (Cancer Risk = 10^{-5} and Hazard Quotient = 1) (µg/g)*
	Surface Soil	*Soil (Surface and Subsurface)*	
Residential Area 1	**7.382**	**10.21**	6.4
Residential Area 2	**8.751**	**8.7**	6.4
Residential Area 3	**11.16**	**13.05**	6.4
Residential Area 4	**9.391**	**12.3**	6.4
Waterfront Plaza	**69.28**	18.13	27
Mixed Residential/Commercial Area 1	**8.111**	**11.02**	6.4
Mixed Residential/Commercial Area 2	**19.31**	**47.39**	6.4
Commercial Area 1	7.361	7.234	27
Commercial Area 2	9.947	13.33	27
Commercial Area 3	12.24	9.59	27
Commercial Area 4	19.38	16.68	27

Notes:
Bold and Shading: EPC exceeds the arsenic RBC

Based on the information presented in the above table, all Redevelopment Areas, with the exception of Commercial Areas 1 through 4 require further action to mitigate potential exposure to arsenic through direct contact with soil. Using an iterative approach, specific soil sampling locations containing the highest concentrations of arsenic from these Redevelopment Areas were removed from the soil datasets used to calculate the EPCs until the EPCs met the RBC. The results of this analysis are presented in Table 10 for each Redevelopment Area.

The Part 201 GCC for arsenic based on direct contact are 7.6 µg/g for residential land use and 37 µg/g for non-residential land use, which are higher in comparison to the arsenic RBCs calculated in this memorandum (residential = 6.4 µg/g; commercial = 27 µg/g) using the same target cancer risk (10^{-5}) and hazard quotient (1). Therefore, the iterative approach was also conducted using the Part 201 GCC.

The table below presents a comparison of the arsenic EPC to the Part 201 GCC for each redevelopment area. The MDEQ GCC is based on a cancer risk of 1 x 10^{-5} and hazard quotient of 1.

Redevelopment Area	***EPC (µg/g)***		***Part 201 GCC (µg/g)***
	Surface Soil	***Soil (Surface and Subsurface)***	
Residential Area 1	7.382	**10.71**	7.6
Residential Area 2	**8.751**	**8.7**	7.6
Residential Area 3	**11.16**	**13.05**	7.6
Residential Area 4	**9.391**	**12.3**	7.6
Waterfront Plaza	69.28 (34.7) (1)	18.13	37
Mixed Residential/Commercial Area 1	**8.111**	**11.02**	7.6
Mixed Residential/Commercial Area 2	**19.31**	**47.39**	7.6
Commercial Area 1	7.361	7.234	37
Commercial Area 2	9.947	13.33	37
Commercial Area 3	12.24	9.59	37
Commercial Area 4	19.38	16.68	37

Notes:
Bold and Shading: EPC exceeds the Part 201 GCC
(1) The calculated EPC is greater than the maximum detected concentration of 34.7 µg/g for surface and subsurface soil due to the low sample numbers. Given that the Part 201 GCC is greater than the maximum detected concentration, no locations need to be removed.

Based on the information presented in the above table, all Redevelopment Areas, with the exception of Waterfront Plaza and Commercial Areas 1 through 4 require further action to mitigate potential exposure to arsenic through direct contact with soil. Using an iterative approach, specific soil sampling locations containing the highest concentrations of arsenic from these Redevelopment Areas were removed from the soil datasets used to calculate the EPCs until the EPCs met the MDEQ GCC. The results of this analysis are presented in Table 11 for each Redevelopment Area.

2.1.3 Arsenic RBC (Cancer Risk = 10-6; Hazard Quotient = 1)

The table below presents a comparison of the arsenic EPC to the calculated arsenic RBC for each development area. The calculated RBC is based on a cancer risk of 1 x 10^{-6} and hazard quotient of 1.

Development Area	*EPC (µg/g)*		*Arsenic RBC (Cancer Risk = 10^{-6} and Hazard Quotient = 1) (µg/g)*
	Surface Soil	*Soil (Surface and Subsurface)*	
Residential Area 1	**7.382**	**10.21**	0.64
Residential Area 2	**8.751**	**8.7**	0.64
Residential Area 3	**11.16**	**13.05**	0.64
Residential Area 4	**9.391**	**12.3**	0.64
Waterfront Plaza	**69.28**	**18.13**	2.7
Mixed Residential/Commercial Area 1	**8.111**	**11.02**	0.64
Mixed Residential/Commercial Area 2	**19.31**	**47.39**	0.64
Commercial Area 1	**7.361**	**7.234**	2.7
Commercial Area 2	**9.947**	**13.33**	2.7
Commercial Area 3	**12.24**	**9.59**	2.7
Commercial Area 4	**19.38**	**16.68**	2.7

Notes:
Bold and Shading: EPC exceeds the arsenic RBC

Based on the information presented in the above table, all Redevelopment Areas require further action to mitigate potential exposure to arsenic through direct contact with soil. The calculated arsenic RBCs for both residential and non-residential land use based on a cancer risk of 1 x 10^{-6} are extremely low, and below the Part 201 SDBL of 5.8 µg/g. Virtually all soil sampling locations within each Redevelopment Area would need to be removed to meet the arsenic RBCs based on a cancer risk of 1 x 10^{-6}, and; therefore, the iterative approach was not conducted for this scenario. However, given that the calculated RBCs based on a cancer risk of 1 x 10^{-6} are below the Part 201 SDBL, the iterative approach was conducted using the Part 201 SDBL. The results of this analysis are presented in Table 12 for each Redevelopment Area.

3.0 Development of Risk-Based Concentrations for PCBs in Soil

The RBCs for PCBs were developed using the same methodology used in the development of the RBCs for arsenic (see Section 2.0), with the exception of the changes discussed in Section 3.1. A summary of the RBCs developed for PCBs in soil is presented in Section 3.2

3.1 Summary of Changes in the RBC Development

The following changes to the RBC development methodology presented for arsenic (Section 2.0) were applied in the development of the PCBs for soil.

- ***Development of Recreational User and Resident RBCs for PCBs***

The recreational user and resident RBCs were calculated using age-adjusted ingestion and dermal factors, consistent with the approach applied by MDEQ in the development of the Part 201 GCC (MDEQ, 2013) for residential land use. These age-adjusted ingestion and dermal factors were applied in the following RBC equations:

Carcinogenic Endpoint:

$$RBC_{soil} = \frac{TR \times AT_c}{((CSF \times IF \times ABS_o \times CF \times EFa) + (CSF \times DF \times ABS_d \times CF \times EFb) + (URF \times FT \times EFa \times ED \times (1/PEF))}$$

Non-Carcinogenic Endpoint:

$$RBC_{soil} = \frac{THQ \times ATnc}{((1/RfD) \times IF \times ABS_o \times CF \times EFa) + ((1/RfD) \times DF \times ABS_d \times CF \times EFb) + ((1/RfC) \times EFa \times ED \times FT \times (1/(PEF))}$$

Where:

RBC_{soil}	=	Risk-based concentration in soil based on ingestion, dermal contact, and inhalation exposure (mg/kg)
TR	=	Target Cancer Risk
THQ	=	Target Hazard Quotient
ATc	=	Averaging Time - carcinogen
ATnc	=	Averaging Time - non-carcinogen – child and adult (days)
CSF	=	Cancer Slope Factor – oral/dermal - chemical-specific $(mg/kg/day)^{-1}$
URF	=	Unit Risk Factor - inhalation - chemical-specific $(mg/m^3)^{-1}$
RfD	=	Reference Dose – oral/dermal - chemical-specific (mg/kg/day)
RfC	=	Reference Concentration - inhalation - chemical-specific (mg/m^3)
ABS_o	=	Absorption Factor - oral - chemical-specific (%/100)
ABS_d	=	Absorption Factor - dermal - chemical-specific (%/100)
IF	=	Age-adjusted Ingestion Factor (mg-year/kg-day)
DF	=	Age-adjusted Dermal Factor (mg-year/kg-day)
CF	=	Conversion Factor $(1.0 \times 10^{-6}$ kg/mg)
FT	=	Fraction Time Exposed (hours/24 hours)
EFa	=	Exposure Frequency (days/year) – ingestion/inhalation
EFb	=	Exposure Frequency (days/year) – dermal
ED	=	Exposure Duration – child and adult (years)
PEF	=	Particulate Emission Factor - inhalation (m^3/kg)

With the exception of the age-adjusted ingestion factor, age-adjusted dermal factor, exposure duration, and oral absorption factor, all other exposure assumptions were identical to those applied in the equations for the derivation of the recreational user and resident RBCs for arsenic indicated above (Section 2.0) and thus are not reproduced here.

The age-adjusted ingestion factor of 114 mg-year/kg-day was obtained from MDEQ (2013), and calculated using the child and adult ingestion rates, exposure durations, and body weights. The age-adjusted dermal factor of 353 mg-year/kg-day was also obtained from MDEQ (2013), and calculated using the child and adult skin surface areas available for contact, soil to skin adherence factors, exposure durations, and body weights. The exposure duration is 30 years, and accounts for the exposure durations of the child (6 years) and adult (24 years), consistent with the approach applied by MDEQ (2013). It is common to see federal and state agencies apply age-adjusted ingestion and dermal factors in the development of criteria using a risk-based approach. U.S. EPA applies age-adjusted ingestion and dermal factors in the development of

their Regional Screening Levels (RSLs)[6], and U.S. EPA also recommends using age-adjusted ingestion and dermal factors in the development of risk-based Preliminary Remediation Goals (PRGs)[7].

- ***Oral Absorption Factors***

An oral absorption factor of 1 was applied for PCBs, consistent with the oral absorption factor applied in the RI Report. Oral absorption factors are chemical-specific; however, it is conservatively assumed that 100 percent of PCBs is absorbed into the body through oral exposure. Unlike arsenic, oral absorption factors specific to PCBs are not available, and; therefore, assuming a factor of 1 is considered to be appropriate.

3.2 Summary of Risk-Based Concentrations for PCBs

The calculated RBCs for PCBs in soil are presented in the following tables:

Receptor	*Table Reference*
Trespasser	Table 13
Recreational User	Table 14
Resident	Table 15
Commercial Worker	Table 16
Utility Worker	Table 17
Construction Worker	Table 18

Table 19 presents a summary of the calculated RBCs for each receptor at target cancer risk levels of 10^{-4}, 10^{-5}, and 10^{-6}, respectively, and a target hazard quotient of 1.0. The proposed RBCs for PCBs for each area of redevelopment were selected similar to the approach presented above for arsenic, and are summarized in the table below.

[6] U.S. EPA, 2014. Regional Screening Levels for Chemical Contaminants at Superfund Sites, User's Guide, May 2014.
[7] U.S. EPA, 1991. Risk Assessment Guidance for Superfund: Volume I – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals, EPA/540/R-92/003, December 1991.

Redevelopment Area	*PCBs RBC (µg/g)*		
	Cancer Risk = 10^{-4} Hazard Quotient = 1	***Cancer Risk = 10^{-5} Hazard Quotient = 1***	***Cancer Risk = 10^{-6} Hazard Quotient = 1***
Residential Area 1	4.2	2.5	0.25
Residential Area 2	4.2	2.5	0.25
Residential Area 3	4.2	2.5	0.25
Residential Area 4	4.2	2.5	0.25
Waterfront Plaza	9.1	9.1	0.91
Mixed Residential/Commercial Area 1	4.2	2.5	0.25
Mixed Residential/Commercial Area 2	4.2	2.5	0.25
Commercial Area 1	9.1	9.1	0.91
Commercial Area 2	9.1	9.1	0.91
Commercial Area 3	9.1	9.1	0.91
Commercial Area 4	9.1	9.1	0.91

These RBCs are based on the most sensitive receptor that is present within these areas, and target cancer risk range of 10^{-6} to 10^{-4} and target hazard quotient of 1.0.

TABLE 1

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SOIL
CURRENT/ FUTURE UTILITY WORKER INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

$$PEF_{SC} = Q/C_{sr} \times 1/F_D \times [(T \times A_R) / (556 \times ((W/3)^{0.4} \times ((365\ d/y - p) / 365\ d/y) \times VKT)]$$

$$Q/C_{sr} = A \times EXP [(\ln A_s - B)^2 / C]$$

INPUT PARAMETERS		*REFERENCE*
PEF_{sc}/ subchronic road particulate emission factor (m^3/kg) =	**2.39E+09**	Equation 5-5, U.S. EPA, 2002
Q/C_{sr}/ inverse of ratio of the 1-h geometric mean air concentration =	23.02	Equation 5-6, U.S. EPA, 2002
A/ constant (unitless) =	12.9351	U.S. EPA, 2002
B/ constant (unitless) =	5.7383	U.S. EPA, 2002
C/ constant (unitless) =	71.7711	U.S. EPA, 2002
A_s/ areal extent of site surface soil contamination (acres) =	0.5	U.S. EPA, 2002
F_D/ dispersion correction factor (unitless) =	0.185	U.S. EPA, 2002
T/ exposure interval (s) =	7.88E+08	U.S. EPA, 2002 (site-specific, within 25 year duration)
A_R/ surface area of contaminated road segment (m^2) =	274	U.S. EPA, 2002 (AR = LR*WR*0.092903 m2/ft2)
LR - length of road segment (ft) =	148	U.S. EPA, 2002
WR - width of road segment (ft) =	20	U.S. EPA, 2002
W/ mean vehicle weight (tons) =	8	U.S. EPA, 2002, Assumes 20 two-ton cars and 10 twenty-ton trucks (W = (20*2+10*20)/30)
p/ number of days with at least 0.01 inches of precipitation (days/yr) =	180	U.S. EPA, 2002
VKT/ sum of fleet vehicle kilometres travelled during the exposure duration (km) =	27.0	Assuming that the area is configured as a square with the unpaved construction access road segment dividing the square evenly, the road length would be equal to the square root of 2023.5 m^2, also equal to 45 m or 0.045 km. Assuming that each vehicle travels the length of the road for a total of 20 days, (30*0.045*20).

Reference:

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

TABLE 2

DERIVATION OF PARTICULATE EMISSION FACTOR (PEF) FOR SOIL
FUTURE CONSTRUCTION WORKER INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

$$PEF_{SC} = Q/C_{sr} \times 1/F_D \times [(T \times A_R) / (556 \times ((W/3)^{0.4} \times ((365\ d/y - p) / 365\ d/y) \times VKT)]$$

$$Q/C_{sr} = A \times EXP [(\ln A_s - B)^2 / C]$$

INPUT PARAMETERS		*REFERENCE*
PEF_{sc}/ subchronic road particulate emission factor (m^3/kg) =	**1.59E+07**	Equation 5-5, U.S. EPA, 2002
Q/C_{sr}/ inverse of ratio of the 1-h geometric mean air concentration =	23.02	Equation 5-6, U.S. EPA, 2002
A/ constant (unitless) =	12.9351	U.S. EPA, 2002
B/ constant (unitless) =	5.7383	U.S. EPA, 2002
C/ constant (unitless) =	71.7711	U.S. EPA, 2002
A_s/ areal extent of site surface soil contamination (acres) =	0.5	U.S. EPA, 2002
F_D/ dispersion correction factor (unitless) =	0.185	U.S. EPA, 2002
T/ total time over which construction occurs (s) =	3.15E+07	U.S. EPA, 2002 (site-specific, within a 1 year construction campaign)
A_R/ surface area of contaminated road segment (m^2) =	274	U.S. EPA, 2002 (AR = LR*WR*0.092903 m2/ft2)
LR - length of road segment (ft) =	148	U.S. EPA, 2002
WR - width of road segment (ft) =	20	U.S. EPA, 2002
W/ mean vehicle weight (tons) =	8	U.S. EPA, 2002, Assumes 20 two-ton cars and 10 twenty-ton trucks (W = (20*2+10*20)/30)
p/ number of days with at least 0.01 inches of precipitation (days/yr) =	180	U.S. EPA, 2002
VKT/ sum of fleet vehicle kilometres travelled during the exposure duration (km) =	162	Assuming that the area is configured as a square with the unpaved construction access road segment dividing the square evenly, the road length would be equal to the square root of 2023.5 m^2, also equal to 45 m or 0.045 km. Assuming that each vehicle travels the length of the road once per day, 5 days per week for a total of 120 days, (30*0.045*120).

Reference:

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

TABLE 3

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
TRESPASSER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption Factor, ABS_o	Dermal Absorption Factor, ABS_d	Trespasser		Soil Risk-Based Concentration
									Carcinogen	Non-Carcinogen	
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	(%/100)	(%/100)	TR Adolescent (µg/g)	THQ Adolescent (µg/g)	RBC_{soil} (1) (µg/g)
Metals											
Arsenic (10^{-4} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	1.96E+03	1.26E+03	1,258
Arsenic (10^{-5} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	1.96E+02	1.26E+03	196
Arsenic (10^{-6} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	1.96E+01	1.26E+03	20

Notes:

-- = Not Available

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) The basis for SA is assuming that potential exposed skin (U.S. EPA Exhibit C-1) consists of the face (425 cm^2), hands (700 cm^2), forearms (787 cm^2), lower legs (1610 cm^2) and feet (949 cm^2).

(3) The basis for the FT is the 50th percentile from Table 16-1, Recommended Values for Activity Factors - Time Outdoors (total).
The time spent outdoors for 11-16 years old of 100 min/day equates to 1.7 hours (100 min/60 min). The final FT is double the 50th percentile value or 3.4 hours.

(4) The basis for the EF is the 50th percentile from Table 16-1, Recommended Values for Activity Factors - Time Outdoors (total).
Ingestion/Inhalation: The time spent outdoors for 11-16 years old of 100 min/day out of a possible 365 days equates to 25 days (CT) (100 min/day x 365 days x 1 hour/60 min x 1 day/24 hours).
The final EF is double the 50th percentile value or 50 days.
Dermal: the time spent outdoors for 11-16 years old of 100 min/day out of a possible 245 days equates to 17 days (CT) (100 min/day x 365 days x 1 hour/60 min x 1 day/24 hours).
The final EF is double the 50th percentile value or 34 days.

(5) Trespasser is a 7 through 16 year old therefore the exposure duration is 10 years, based on U.S. EPA Region 4 (2000).

Trespasser Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	U.S. EPA RSL Table
Ingestion Rate (mg/day) - adult	IR	100	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	4,471	U.S. EPA, 2004 (2)
Adherence Factor (mg/cm^2)	AF	0.2	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	chemical-specific	see Section 2.2 of the Memorandum
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	3.4/24	U.S. EPA, 2008 (3)
Exposure Frequency (days/year) - ingestion/inhalation	EFa	50	see Section 2.2 of the Memorandum (4)
Exposure Frequency (days/year) - dermal	EFb	34	see Section 2.2 of the Memorandum (4)
Exposure Duration (years)	ED	10	U.S. EPA, 2000 (5)
Body Weight (kg)	BW	45	U.S. EPA, 2000
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	3,650	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{ED \times [(CSF \times IR \times EFa \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times EFb \times CF \times ABS_d)/BW + (URF \times EFa \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED \times [((1/RfD) \times IR \times EFa \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times EFb \times CF \times ABS_d)/BW + ((1/RfC) \times EFa \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA RSL Table, U.S. EPA Regional Screening Levels Summary Table, November 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2000: Region 4 Human Health Risk Assessment Bulletins – Supplement to RAGS, Section 4: Exposure Assessment, May.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

U.S. EPA, 2008: Child Specific Exposure Factors Handbook, September 2008.

TABLE 4

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
RECREATIONAL USER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Chemical of Potential Concern (COPC)	*CSF*		*URF*	*RfD*		*RfC*	*Oral Absorption Factor, ABS_o (%/100)*	*Dermal Absorption Factor, ABS_d (%/100)*	*Recreational User*		*Soil Risk-Based Concentration RBC_{soil} (1) (µg/g)*
	oral 1/(mg/kg-d)	*dermal 1/(mg/kg-d)*	*inhalation 1/(mg/m³)*	*oral (mg/kg-d)*	*dermal (mg/kg-d)*	*inhalation (mg/m³)*			*TR Child & Adult (µg/g)*	*THQ Child (µg/g)*	
Metals											
Arsenic (10^{-4} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	3.20E+02	1.78E+02	178
Arsenic (10^{-5} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	3.20E+01	1.78E+02	32
Arsenic (10^{-6} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	3.20E+00	1.78E+02	3.2

Notes:

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) The basis for the EF is the 50th percentile from Table 16-1, Recommended Values for Activity Factors - Time Outdoors (total).
Ingestion/Inhalation: The time spent outdoors for 6-12 month olds of 139 min/day out of a possible 365 days equates to 35 days (CT) (139 min/day x 365 days x 1 hour/60 min x 1 day/24 hours).
The final EF is double the 50th percentile value or 70 days.
Dermal: the time spent outdoors for 6-12 month olds of 139 min/day out of a possible 245 days equates to 24 days (CT) (139 min/day x 365 days x 1 hour/60 min x 1 day/24 hours).
The final EF is double the 50th percentile value or 48 days.

(3) The basis for the FT is based on ages 3-5 yrs from Table 16-1, Recommended Values for Activity Factors - Time Outdoors Playing on Dirt.
It is assumed that the adult will spend the same amount of time outdoors with their child.

Recreational User Exposure Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	U.S. EPA RSL Table
Ingestion Rate (mg/day) - child	IR_c	200	U.S. EPA, 2002
Ingestion Rate (mg/day) - adult	IR_a	100	U.S. EPA, 2002
Surface Area Exposed (cm^2/day) - child	SA_c	2,800	U.S. EPA, 2004
Surface Area Exposed (cm^2/day) - adult	SA_a	5,700	U.S. EPA, 2004
Adherence Factor (mg/cm^2) - child	AF_c	0.2	U.S. EPA, 2004
Adherence Factor (mg/cm^2) - adult	AF_a	0.07	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	chemical-specific	see Section 2.2 of the Memorandum
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Exposure Frequency (days/year) - ingestion/inhalation	EFa	70	see Section 2.2 of the Memorandum (2)
Exposure Frequency (days/year) - dermal	EFb	48	see Section 2.2 of the Memorandum (2)
Exposure Duration (years) - child	ED_c	6	U.S. EPA, 2004
Exposure Duration (years) - adult	ED_a	24	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	2/24	U.S. EPA, 2008 (3)
Body Weight (kg) - child	BW_c	15	U.S. EPA, 2008
Body Weight (kg) - adult	BW_a	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carc. (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - noncarc. (days) - child	ATnc	2,190	U.S. EPA, 1989
Averaging Time - noncarc. (days) - adult	ATnc - a	8,760	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{[(((CSF \times IR_c \times EFa \times ED_c \times CF \times ABS_o)/BW_c + (CSF \times SA_c \times AF_c \times EFb \times ED_c \times CF \times ABS_d)/BW_c + (URF \times FT \times EFa \times ED_c \times (1/PEF))) + (((CSF \times IR_a \times EFa \times ED_a \times CF \times ABS_o)/BWa + (CSF \times SA_a \times AF_a \times EFb \times ED_a \times CF \times ABS_d)/BW_a) + (URF \times FT \times EFa \times ED_a \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED_c \times [(((1/RfD) \times IR_c \times EFa \times CF \times ABS_o)/BW_c + ((1/RfD) \times SA_c \times AF_c \times EFb \times CF \times ABS_d)/BW_c + ((1/RfC) \times FT \times EFa \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA RSL Table, U.S. EPA Regional Screening Levels Summary Table, November 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

U.S. EPA, 2008: Child Specific Exposure Factors Handbook, September 2008.

TABLE 5

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
RESIDENTIAL ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Chemical of Potential Concern (COPC)	*CSF*		*URF*	*RfD*		*RfC*	*Oral Absorption Factor, ABS_o*	*Dermal Absorption Factor, ABS_d*	*Resident*		*Soil Risk-Based Concentration RBC_{soil} (1)*
	oral	*dermal*	*inhalation*	*oral*	*dermal*	*inhalation*			*TR*	*THQ*	
	1/(mg/kg-d)	*1/(mg/kg-d)*	*1/(mg/m³)*	*(mg/kg-d)*	*(mg/kg-d)*	*(mg/m³)*	*(%/100)*	*(%/100)*	*Child & Adult (µg/g)*	*Child (µg/g)*	*(µg/g)*
Metals											
Arsenic (10^{-4} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	6.39E+01	3.56E+01	36
Arsenic (10^{-5} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	6.39E+00	3.56E+01	6.4
Arsenic (10^{-6} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	6.39E-01	3.56E+01	0.64

Notes:

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) The basis for the FT is based on ages 3-5 yrs from Table 16-1, Recommended Values for Activity Factors - Time Outdoors Playing on Dirt.

Resident Exposure Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	U.S. EPA RSL Table
Ingestion Rate (mg/day) - child	IR_c	200	U.S. EPA, 2002
Ingestion Rate (mg/day) - adult	IR_a	100	U.S. EPA, 2002
Surface Area Exposed (cm^2/day) - child	SA_c	2,800	U.S. EPA, 2004
Surface Area Exposed (cm^2/day) - adult	SA_a	5,700	U.S. EPA, 2004
Adherence Factor (mg/cm^2) - child	AF_c	0.2	U.S. EPA, 2004
Adherence Factor (mg/cm^2) - adult	AF_a	0.07	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	chemical-specific	see Section 2.2 of the Memorandum
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Exposure Frequency (days/year) - ingestion/inhalation	EFa	350	see Section 2.2 of the Memorandum
Exposure Frequency (days/year) - dermal	EFb	245	see Section 2.2 of the Memorandum
Exposure Duration (years) - child	ED_c	6	U.S. EPA, 2004
Exposure Duration (years) - adult	ED_a	24	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	2/24	U.S. EPA, 2008 (2)
Body Weight (kg) - child	BW_c	15	U.S. EPA, 2008
Body Weight (kg) - adult	BW_a	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carc. (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - noncarc. (days) - child	ATnc	2,190	U.S. EPA, 1989
Averaging Time - noncarc. (days) - adult	ATnc - a	8,760	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{[(((CSF \times IR_c \times EFa \times ED_c \times CF \times ABS_o)/BW_c + (CSF \times SA_c \times AF_c \times EFb \times ED_c \times CF \times ABS_d)/BW_c + (URF \times FT \times EFa \times ED_c \times (1/PEF))) + (((CSF \times IR_a \times EFa \times ED_a \times CF \times ABS_o)/BW_a + (CSF \times SA_a \times AF_a \times EFb \times ED_a \times CF \times ABS_d)/BW_a) + (URF \times FT \times EFa \times ED_a \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED_c \times [(((1/RfD) \times IR_c \times EFa \times ABS_o)/BW_c + ((1/RfD) \times SA_c \times AF_c \times EFb \times CF \times ABS_d)/BW_c + ((1/RfC) \times EFa \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA RSL Table, U.S. EPA Regional Screening Levels Summary Table, November 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

U.S. EPA, 2008: Child Specific Exposure Factors Handbook, September 2008.

TABLE 6

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
COMMERCIAL WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption	Dermal Absorption	Commercial Worker		Soil Risk-Based
									Carcinogen	Non-Carcinogen	Concentration
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	Factor, ABS$_o$ (%/100)	Factor, ABS$_d$ (%/100)	TR Adult (µg/g)	THQ Adult (µg/g)	RBC$_{soil}$ (1) (µg/g)
Metals											
Arsenic (10^{-4} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.00E-01	3.0E-02	2.67E+02	4.27E+02	267
Arsenic (10^{-5} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.00E-01	3.0E-02	2.67E+01	4.27E+02	27
Arsenic (10^{-6} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.00E-01	3.0E-02	2.67E+00	4.27E+02	2.7

Notes:

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Professional Judgment; assumed 8 hour work day.

Commercial Worker Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC$_{soil}$	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	U.S. EPA RSL Table
Ingestion Rate (mg/day) - adult	IR	100	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	3,300	U.S. EPA, 2004
Adherence Factor (mg/cm^2)	AF	0.2	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS$_o$	chemical-specific	see Section 2.2 of the Memorandum
Absorption Factor - Dermal (%/100)	ABS$_d$	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	8/24	Professional Judgement (2)
Exposure Frequency (days/year) - ingestion/inhalation	EFa	245	see Section 2.2 of the Memorandum
Exposure Frequency (days/year) - dermal	EFb	160	see Section 2.2 of the Memorandum
Exposure Duration (years)	ED	25	U.S. EPA, 2004
Body Weight (kg)	BW	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	9,125	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{ED \times [(CSF \times IR \times EFa \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times EFb \times CF \times ABS_d)/BW + (URF \times EFa \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED \times [((1/RfD) \times IR \times EFa \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times EFb \times CF \times ABS_d)/BW + ((1/RfC) \times EFa \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA RSL Table, U.S. EPA Regional Screening Levels Summary Table, November 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

TABLE 7

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption	Dermal Absorption	Utility Worker		Soil Risk-Based
									Carcinogen	Non-Carcinogen	
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	Factor, ABS_o (%/100)	Factor, ABS_d (%/100)	TR Adult (µg/g)	THQ Adult (µg/g)	Concentration RBC_{soil} (1) (µg/g)
Metals											
Arsenic (10^{-4} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	4.36E+03	2.80E+02	280
Arsenic (10^{-5} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	4.36E+02	2.80E+02	280
Arsenic (10^{-6} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	4.36E+01	2.80E+02	44

Notes:

-- = Not Available

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Professional Judgement; assumed 8 hour work day.

(3) Professional Judgement; assumes 5 days/week for 6 months or 120 days/year.

(4) Professional Judgement; assumes utility maintenance activities occurs within a one year time period.

Utility Worker Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	U.S. EPA RSL Table
Ingestion Rate (mg/day) - adult	IR	330	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	3,300	U.S. EPA, 2004
Adherence Factor (mg/cm^2)	AF	0.3	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	chemical-specific	see Section 2.2 of the Memorandum
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	8/24	Professional Judgement (2)
Exposure Frequency (days/year)	EF	120	Professional Judgement (3)
Exposure Duration (years)	ED	1	Professional Judgement (4)
Body Weight (kg)	BW	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	365	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	2.39E+09	U.S. EPA, 2002; See Table 1

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times CF \times ABS_d)/BW + (URF \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times CF \times ABS_d)/BW + ((1/RfC) \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA RSL Table, U.S. EPA Regional Screening Levels Summary Table, November 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 200

TABLE 8

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
CONSTRUCTION WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

									Construction Worker		Soil
	CSF		URF	RfD		RfC	Oral Absorption	Dermal Absorption	Carcinogen	Non-Carcinogen	Risk-Based
									TR	THQ	Concentration
Chemical of	oral	dermal	inhalation	oral	dermal	inhalation	Factor, ABS_o	Factor, ABS_d	Adult	Adult	RBC_{soil} (1)
Potential Concern	1/(mg/kg-d)	1/(mg/kg-d)	$1/(mg/m^3)$	(mg/kg-d)	(mg/kg-d)	(mg/m^3)	(%/100)	(%/100)	(µg/g)	(µg/g)	(µg/g)
Metals											
Arsenic (10^{-4} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	1.03E+03	1.49E+03	1,028
Arsenic (10^{-5} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	1.03E+02	1.49E+03	103
Arsenic (10^{-6} cancer risk)	1.50E+00	1.50E+00	4.30E+00	3.00E-04	3.00E-04	1.50E-05	6.0E-01	3.0E-02	1.03E+01	1.49E+03	10.3

Notes:

-- = Not Available

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Professional Judgement; assumed 8 hour work day.

(3) Professional Judgement; assumes 5 days/week for 1 month or 20 days/year.

Construction Worker Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	U.S. EPA RSL Table
Ingestion Rate (mg/day) - adult	IR	330	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	3,300	U.S. EPA, 2004
Adherence Factor (mg/cm^2)	AF	0.3	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	chemical-specific	see Section 2.2 of the Memorandum
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	8/24	Professional Judgement (2)
Exposure Frequency (days/year)	EF	20	Professional Judgement (3)
Exposure Duration (years)	ED	25	U.S. EPA, 2004
Body Weight (kg)	BW	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	9,125	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.59E+07	U.S. EPA, 2002; see Table 2

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times CF \times ABS_d)/BW + (URF \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times CF \times ABS_d)/BW + ((1/RfC) \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA RSL Table, U.S. EPA Regional Screening Levels Summary Table, November 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

TABLE 9

SUMMARY OF RISK-BASED CONCENTRATIONS (RBCs) FOR ARSENIC IN SOIL
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Chemical of Potential Concern (COPC)	*Units*	*Risk-Based Concentration for Soil, RBC_{soil}*						*Minimum RBC_{soil}*		
		Trespasser	*Recreational User*	*Resident*	*Commercial Worker*	*Utility Worker*	*Construction Worker*	*Residential (1)*	*Commercial (2)*	*Commercial+Recreational (3)*
TARGET CANCER RISK = 1.0×10^{-4}; TARGET HAZARD QUOTIENT = 1.0										
Arsenic	µg/g	1,258	178	36	267	280	1,028	36	267	178
TARGET CANCER RISK = 1.0×10^{-5}; TARGET HAZARD QUOTIENT = 1.0										
Arsenic	µg/g	196	32	6.4	27	280	103	6.4	27	27
TARGET CANCER RISK = 1.0×10^{-6}; TARGET HAZARD QUOTIENT = 1.0										
Arsenic	µg/g	20	3.2	0.64	2.7	44	10.3	0.64	2.7	2.7

Notes:
(1) RBC_{soil} for the residential areas include all receptors.
(2) RBC_{soil} for the commercial areas include all receptors, except residents and recreational users.
(3) RBC_{soil} for the commercial+recreational areas include all receptors, except residents.

TABLE 10

LOCATIONS REQUIRING REMOVAL TO MEET THE ARSENIC RBC BASED ON A CANCER RISK = 10^{-5} AND HAZARD QUOTIENT = 1
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Residential Area 1	Surface Soil	7.382	SB-102 (0-1 ft bgs)	16.2	6.318	6.4
			SB-132 (0-1 ft bgs)	13.4		
	Surface and Subsurface Soil	10.71	SB-102 (0-1 ft bgs)	16.2	6.384	6.4
			SB-104 (3-5) ft bgs	25.3 J		
			SB-104 (5-7) ft bgs	92 J		
			SB-104 (8-10) ft bgs	29 J		
			SB-118 (7.5-9.5) ft bgs	21 J		
			SB-132 (0-1) ft bgs	13.4		
			SB-132 (8-10) ft bgs	16.7		
Residential Area 2	Surface Soil	8.751	SB-105 (0-1) ft bgs	9.6	5.805	6.4
			SB-124 (0-1) ft bgs	8.4 J		
			SB-125 (0-1) ft bgs	13.5		
	Surface and Subsurface Soil	8.7	SB-105 (0-1) ft bgs	9.6	6.439	6.4
			SB-105 (1-3) ft bgs	17.5		
			SB-124 (0-1) ft bgs	8.4 J		
			SB-124 (7-9) ft bgs	8.9 J		
			SB-125 (0-1) ft bgs	13.5		
			SB-126 (7.5-9.5) ft bgs	9.4		
Residential Area 3	Surface Soil	11.16	MW-15 (0-2) ft bgs	19.9	6.262	6.4
			SB-137 (0-1) ft bgs	8.7		
			SB-139 (0-1) ft bgs	12.5		
			SB-140 (0-1) ft bgs	12.1		
			SB-141 (0-1) ft bgs	8.5		
	Surface and Subsurface Soil	13.05	MW-15 (0-2) ft bgs	19.9	5.682	6.4
			MW-15 (4-6) ft bgs	11.9		
			SB-134 (1.5-3.5) ft bgs	20.3		
			SB-136 (8-10) ft bgs	21.1		
			SB-137 (0-1) ft bgs	8.7		
			SB-137 (8-10) ft bgs	26.4		
			SB-139 (0-1) ft bgs	12.5		
			SB-140 (0-1) ft bgs	12.1		
			SB-140 (8-10) ft bgs	19/15		
			SB-141 (0-1) ft bgs	8.5		
Residential Area 4	Surface	9.391	DG4 (0-1.5) ft bgs	16	6.133	6.4
			SB-301 (0-1) ft bgs	21.6		
			TP-311 (0-1) ft bgs	13.9		
			TP-314 (0-1) ft bgs	12.1		
	Surface and Subsurface Soil	12.3	DG4 (0-1.5) ft bgs	16	6.233	6.4
			SB-301 (0-1) ft bgs	21.6		
			SB-301 (5.5-7.5) ft bgs	55.8 J/14.2 J		
			TP-310 (8-10) ft bgs	16.4		
			TP-311 (0-1) ft bgs	13.9		
			TP-314 (0-1) ft bgs	12.1		
			TP-314 (6-8) ft bgs	25		

TABLE 10

LOCATIONS REQUIRING REMOVAL TO MEET THE ARSENIC RBC BASED ON A CANCER RISK = 10^{-5} AND HAZARD QUOTIENT = 1
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Waterfront Plaza	Surface Soil	69.28	TP-321 (0-1) ft bgs	34.7	NC	27
Mixed Residential/Commercial Area 1	Surface Soil	8.111	TP-306 (0.5-1.5) ft bgs	20	5.189	6.4
	Surface and Subsurface Soil	11.02	TP-303 (6-8) ft bgs	15	6.469	6.4
			TP-306 (0.5-1.5) ft bgs	20		
			TP-306 (6-7) ft bgs	--/20		
Mixed Residential/Commercial Area 2	Surface Soil	19.31	MW-19 (0-2) ft bgs	18	6.424	6.4
			SB-208 (0-1) ft bgs	30.8		
			SB-209 (0-1) ft bgs	21.9		
			SB-220 (0-1) ft bgs	12.3 J		
			SB-230 (0-1) ft bgs	24.3 J		
			SB-231 (0-1) ft bgs	17.6		
			SB-232 (0-1) ft bgs	49.6 J		
			SB-234 (0-1) ft bgs	15.9		
			SB-235 (0.5-1.5) ft bgs	12.1		
			SB-236 (0-1) ft bgs	13.2		
			SB-237 (0-1) ft bgs	39.6		
			SB-238 (0-1) ft bgs	39.3		
			SB-240 (0-1) ft bgs	12.6 J		
			SB-241 (0-1) ft bgs	13.6 J		
			SB-243 (0-1) ft bgs	9.9 J		
			SB-244 (0-1) ft bgs	13.6 J		
			SB-303 (0-2) ft bgs	12.8		
			SB-304 (0-2) ft bgs	12.1		
			SB-306 (0-1) ft bgs	11.4		
			SB-310 (0-1) ft bgs	10.3		
			SB-312 (0-1) ft bgs	95.4		
			SB-2010 (0-1) ft bgs	12.5		
			SB-2013 (0-1) ft bgs	31.4		
			TP-340 (0-1) ft bgs	18.7		
			TP-342 (0-1) ft bgs	102		
			TP-343 (0-1) ft bgs	25.3		
	Surface and Subsurface Soil	47.39	CTP-4 (4-) ft bgs	14.8	6.366	6.4
			MW-19 (0-2) ft bgs	18		
			SB-208 (0-1) ft bgs	30.8		
			SB-209 (0-1) ft bgs	21.9		
			SB-216 (0-4) ft bgs	19		
			SB-218 (2.5-4.5) ft bgs	15.1 J		
			SB-220 (0-1) ft bgs	12.3 J		
			SB-222 (1.5-3.5) ft bgs	15.7		
			SB-223 (1-4) ft bgs	15.7		
			SB-230 (0-1) ft bgs	24.3 J		
			SB-231 (0-1) ft bgs	17.6		
			SB-232 (0-1) ft bgs	49.6 J		
			SB-232 (6-8) ft bgs	804 J		
			SB-234 (0-1) ft bgs	15.9		
			SB-235 (0.5-1.5) ft bgs	12.1		
			SB-235 (3-5) ft bgs	28.8		

TABLE 10

LOCATIONS REQUIRING REMOVAL TO MEET THE ARSENIC RBC BASED ON A CANCER RISK = 10^{-5} AND HAZARD QUOTIENT = 1
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
	Surface and Subsurface Soil	(continued)	SB-236 (0-1) ft bgs	13.2		
			SB-237 (0-1) ft bgs	39.6		
			SB-237 (2-4) ft bgs	57.9		
			SB-238 (0-1) ft bgs	39.3		
			SB-238 (2-4) ft bgs	49.7/46.7		
			SB-240 (0-1) ft bgs	12.6 J		
			SB-241 (0-1) ft bgs	13.6 J		
			SB-243 (0-1) ft bgs	9.9 J		
			SB-244 (0-1) ft bgs	13.6 J		
			SB-244 (4-6) ft bgs	18.4 J		
			SB-246 (3-4) ft bgs	21.8		
			SB-303 (0-2) ft bgs	12.8		
			SB-304 (0-2) ft bgs	12.1		
			SB-306 (0-1) ft bgs	11.4		
			SB-308 (3-5) ft bgs	16.3		
			SB-310 (0-1) ft bgs	10.3		
			SB-312 (0-1) ft bgs	95.4		
			SB-2010 (0-1) ft bgs	12.5		
			SB-2010 (7-9) ft bgs	17.5		
			SB-2011 (3.4-4.75) ft bgs	15.7		
			SB-2013 (0-1) ft bgs	31.4		
			TP-340 (0-1) ft bgs	18.7		
			TP-340 (3-4) ft bgs	18.1		
			TP-342 (0-1) ft bgs	102		
			TP-342 (3.5-4) ft bgs	17.7		
			TP-343 (0-1) ft bgs	25.3		
			TP-343 (3-4) ft bgs	19.6		
			TP-344 (1-3) ft bgs	16.6		
			TP-344 (4-6) ft bgs	28.3		

Notes:
EPC - Exposure point concentration
J Estimated
ft bgs - Feet below ground surface
RBC - Risk-based concentration

TABLE 11

LOCATIONS REQUIRING REMOVAL TO MEET THE PART 201 GENERIC CLEANUP CRITERIA (DIRECT CONTACT) FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Residential Area 1	Surface and Subsurface Soil	10.71	SB-104 (5-7) ft bgs	92 J	7.61	7.6
			SB-104 (8-10) ft bgs	29 J		
Residential Area 2	Surface Soil	8.751	SB-125 (0-1) ft bgs	13.5	7.348	7.6
	Surface and Subsurface Soil	8.7	SB-105 (1-3) ft bgs	17.5	7.279	7.6
			SB-125 (0-1) ft bgs	13.5		
Residential Area 3	Surface Soil	11.16	MW-15 (0-2) ft bgs	19.9	7.373	7.6
			SB-139 (0-1) ft bgs	12.5		
			SB-140 (0-1) ft bgs	12.1		
	Surface and Subsurface Soil	13.05	MW-15 (0-2) ft bgs	19.9	7.012	7.6
			SB-134 (1.5-3.5) ft bgs	20.3		
			SB-136 (8-10) ft bgs	21.1		
			SB-137 (8-10) ft bgs	26.4		
			SB-139 (0-1) ft bgs	12.5		
			SB-140 (0-1) ft bgs	12.1		
			SB-140 (8-10) ft bgs	19/15		
Residential Area 4	Surface	9.391	DG4 (0-1.5) ft bgs	16	7.245	7.6
			SB-301 (0-1) ft bgs	21.6		
	Surface and Subsurface Soil	12.3	DG4 (0-1.5) ft bgs	16	7.217	7.6
			SB-301 (0-1) ft bgs	21.6		
			SB-301 (5.5-7.5) ft bgs	55.8 J/14.2 J		
			TP-314 (6-8) ft bgs	25		
Mixed Residential/Commercial Area 1	Surface Soil	8.111	TP-306 (0.5-1.5) ft bgs	20	5.189	7.6
	Surface and Subsurface Soil	11.02	TP-306 (0.5-1.5) ft bgs	20	7.198	7.6
			TP-306 (6-7) ft bgs	--/20		
Mixed Residential/Commercial Area 2	Surface Soil	19.31	MW-19 (0-2) ft bgs	18	7.428	7.6
			SB-208 (0-1) ft bgs	30.8		
			SB-209 (0-1) ft bgs	21.9		
			SB-230 (0-1) ft bgs	24.3 J		
			SB-231 (0-1) ft bgs	17.6		
			SB-232 (0-1) ft bgs	49.6 J		
			SB-234 (0-1) ft bgs	15.9		
			SB-236 (0-1) ft bgs	13.2		
			SB-237 (0-1) ft bgs	39.6		
			SB-238 (0-1) ft bgs	39.3		
			SB-240 (0-1) ft bgs	12.6 J		
			SB-241 (0-1) ft bgs	13.6 J		
			SB-244 (0-1) ft bgs	13.6 J		

TABLE 11

LOCATIONS REQUIRING REMOVAL TO MEET THE PART 201 GENERIC CLEANUP CRITERIA (DIRECT CONTACT) FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Mixed Residential/Commercial Area 2	Surface Soil	(Continued)	SB-303 (0-2) ft bgs	12.8		
			SB-312 (0-1) ft bgs	95.4		
			SB-2010 (0-1) ft bgs	12.5		
			SB-2013 (0-1) ft bgs	31.4		
			TP-340 (0-1) ft bgs	18.7		
			TP-342 (0-1) ft bgs	102		
			TP-343 (0-1) ft bgs	25.3		
Mixed Residential/Commercial Area 2	Surface and Subsurface Soil	47.39	MW-19 (0-2) ft bgs	18	7.519	7.6
			SB-208 (0-1) ft bgs	30.8		
			SB-209 (0-1) ft bgs	21.9		
			SB-216 (0-4) ft bgs	19		
			SB-230 (0-1) ft bgs	24.3 J		
			SB-231 (0-1) ft bgs	17.6		
			SB-232 (0-1) ft bgs	49.6 J		
			SB-232 (6-8) ft bgs	804 J		
			SB-234 (0-1) ft bgs	15.9		
			SB-235 (3-5) ft bgs	28.8		
			SB-236 (0-1) ft bgs	13.2		
			SB-237 (0-1) ft bgs	39.6		
			SB-237 (2-4) ft bgs	57.9		
			SB-238 (0-1) ft bgs	39.3		
			SB-238 (2-4) ft bgs	49.7/46.7		
			SB-240 (0-1) ft bgs	12.6 J		
			SB-241 (0-1) ft bgs	13.6 J		
			SB-244 (0-1) ft bgs	13.6 J		
			SB-244 (4-6) ft bgs	18.4 J		
			SB-246 (3-4) ft bgs	21.8		
			SB-303 (0-2) ft bgs	12.8		
			SB-312 (0-1) ft bgs	95.4		
			SB-2010 (0-1) ft bgs	12.5		
			SB-2010 (7-9) ft bgs	17.5		
			SB-2013 (0-1) ft bgs	31.4		
			TP-340 (0-1) ft bgs	18.7		
			TP-340 (3-4) ft bgs	18.1		
			TP-342 (0-1) ft bgs	102		
			TP-342 (3.5-4) ft bgs	17.7		
			TP-343 (0-1) ft bgs	25.3		
			TP-343 (3-4) ft bgs	19.6		
			TP-344 (1-3) ft bgs	16.6		
			TP-344 (4-6) ft bgs	28.3		

Notes:
EPC - Exposure point concentration
J - Estimated
ft bgs - Feet below ground surface
RBC - Risk-based concentration

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Residential Area 1	Surface Soil	7.382	SB-102 (0-1) ft bgs	16.2	5.56	5.8
			SB-103 (0-1) ft bgs	10.6 J		
			SB-120 (0-1) ft bgs	14 J/11 J		
			SB-132 (0-1) ft bgs	13.4		
	Surface and Subsurface Soil	10.71	SB-101 (6.8-8.8) ft bgs	15	5.778	5.8
			SB-102 (0-1) ft bgs	16.2		
			SB-103 (0-1) ft bgs	10.6 J		
			SB-104 (3-5) ft bgs	25.3 J		
			SB-104 (5-7) ft bgs	92 J		
			SB-104 (8-10) ft bgs	29 J		
			SB-109 (8-10) ft bgs	14		
			SB-118 (7.5-9.5) ft bgs	21 J		
			SB-120 (0-1) ft bgs	14 J/11 J		
			SB-132 (0-1) ft bgs	13.4		
			SB-132 (8-10) ft bgs	16.7		
Residential Area 2	Surface Soil	8.751	SB-105 (0-1) ft bgs	9.6	5.805	5.8
			SB-124 (0-1) ft bgs	8.4 J		
			SB-125 (0-1) ft bgs	13.5		
	Surface and Subsurface Soil	8.7	SB-105 (0-1) ft bgs	9.6	5.638	5.8
			SB-105 (1-3) ft bgs	17.5		
			SB-105 (3-5) ft bgs	7.3/7.9		
			SB-105 (8-10) ft bgs	7.8		
			SB-124 (0-1) ft bgs	8.4 J		
			SB-124 (7-9) ft bgs	8.9 J		
			SB-125 (0-1) ft bgs	13.5		
			SB-126 (7.5-9.5) ft bgs	9.4		
			SB-129 (6-8) ft bgs	7.5		
			SB-129 (8-10) ft bgs	7.2		
Residential Area 3	Surface Soil	11.16	MW-15 (0-2) ft bgs	19.9	5.853	5.8
			SB-134 (0-1) ft bgs	5.9		
			SB-135 (0-1) ft bgs	6.6		
			SB-137 (0-1) ft bgs	8.7		
			SB-138 (0-1) ft bgs	6.2		
			SB-139 (0-1) ft bgs	12.5		
			SB-140 (0-1) ft bgs	12.1		
			SB-141 (0-1) ft bgs	8.5		
	Surface and Subsurface Soil	13.05	MW-15 (0-2) ft bgs	19.9	5.374	5.8
			MW-15 (4-6) ft bgs	11.9		
			SB-134 (0-1) ft bgs	5.9		
			SB-134 (1.5-3.5) ft bgs	20.3		
			SB-135 (0-1) ft bgs	6.6		
			SB-136 (8-10) ft bgs	21.1		
			SB-137 (0-1) ft bgs	8.7		
			SB-137 (8-10) ft bgs	26.4		
			SB-138 (0-1) ft bgs	6.2		
			SB-139 (0-1) ft bgs	12.5		
			SB-140 (0-1) ft bgs	12.1		
			SB-140 (8-10) ft bgs	19/15		
			SB-141 (0-1) ft bgs	8.5		

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Residential Area 4	Surface	9.391	DG4 (0-1.5) ft bgs	16	5.798	5.8
			SB-301 (0-1) ft bgs	21.6		
			TP-311 (0-1) ft bgs	13.9		
			TP-312 (0-1) ft bgs	9.7		
			TP-314 (0-1) ft bgs	12.1		
	Surface and Subsurface Soil	12.3	DG4 (0-1.5) ft bgs	16	5.611	5.8
			SB-5 (2.5-3.5) ft bgs	12		
			SB-301 (0-1) ft bgs	21.6		
			SB-301 (5.5-7.5) ft bgs	55.8 J/14.2 J		
			SB-302 (6.8-8.8) ft bgs	12.1		
			TP-310 (8-10) ft bgs	16.4		
			TP-311 (0-1) ft bgs	13.9		
			TP-312 (0-1) ft bgs	9.7		
			TP-314 (0-1) ft bgs	12.1		
			TP-314 (6-8) ft bgs	25		
Waterfront Plaza	Surface Soil	69.28	TP-321 (0-1) ft bgs	34.7	NC	5.8
			SB-321 (0-1) ft bgs	7.2/8.1		
			TP-309 (0-1) ft bgs	6.4		
	Surface and Subsurface Soil	18.13	TP-321 (0-1) ft bgs	34.7	4.632	5.8
			SB-321 (0-1) ft bgs	7.2/8.1		
			TP-309 (0-1) ft bgs	6.4		
Mixed Residential/Commercial Area 1	Surface Soil	8.111	TP-306 (0.5-1.5) ft bgs	20	5.189	5.8
	Surface and Subsurface Soil	11.02	SB-334 (8-10) ft bgs	10.7 J	5.47	5.8
			SB-336 (8-10) ft bgs	10.3 J		
			SB-339 (8-10) ft bgs	11.2 J		
			TP-303 (6-8) ft bgs	15		
			TP-306 (0.5-1.5) ft bgs	20		
			TP-306 (6-7) ft bgs	--/20		
Mixed Residential/Commercial Area 2	Surface Soil	19.31	MW-19 (0-2) ft bgs	18	5.76	5.8
			SB-208 (0-1) ft bgs	30.8		
			SB-209 (0-1) ft bgs	21.9		
			SB-219 (0-1) ft bgs	9.8		
			SB-220 (0-1) ft bgs	12.3 J		
			SB-230 (0-1) ft bgs	24.3 J		
			SB-231 (0-1) ft bgs	17.6		
			SB-232 (0-1) ft bgs	49.6 J		
			SB-233 (0-1) ft bgs	8.5 J		
			SB-234 (0-1) ft bgs	15.9		
			SB-235 (0.5-1.5) ft bgs	12.1		
			SB-236 (0-1) ft bgs	13.2		
			SB-237 (0-1) ft bgs	39.6		
			SB-238 (0-1) ft bgs	39.3		
			SB-240 (0-1) ft bgs	12.6 J		
			SB-241 (0-1) ft bgs	13.6 J		
			SB-243 (0-1) ft bgs	9.9 J		
			SB-244 (0-1) ft bgs	13.6 J		
			SB-303 (0-2) ft bgs	12.8		

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Mixed Residential/Commercial Area 2	Surface Soil	(Continued)	SB-304 (0-2) ft bgs	12.1		
			SB-306 (0-1) ft bgs	11.4		
			SB-310 (0-1) ft bgs	10.3		
			SB-311 (0-1) ft bgs	8.6		
			SB-312 (0-1) ft bgs	95.4		
			SB-2010 (0-1) ft bgs	12.5		
			SB-2013 (0-1) ft bgs	31.4		
			TP-339 (0-1) ft bgs	9		
			TP-340 (0-1) ft bgs	18.7		
			TP-342 (0-1) ft bgs	102		
			TP-343 (0-1) ft bgs	25.3		
Mixed Residential/Commercial Area 2	Surface and Subsurface Soil	47.39	CTP-4 (4-) ft bgs	14.8	5.796	5.8
			MW-19 (0-2) ft bgs	18		
			SB-208 (0-1) ft bgs	30.8		
			SB-208 (4-6) ft bgs	9.5		
			SB-209 (0-1) ft bgs	21.9		
			SB-210 (3-5) ft bgs	9.8		
			SB-214 (3.5-5.5) ft bgs	12.0 J		
			SB-216 (0-4) ft bgs	19		
			SB-218 (2.5-4.5) ft bgs	15.1 J		
			SB-219 (0-1) ft bgs	9.8		
			SB-220 (0-1) ft bgs	12.3 J		
			SB-222 (1.5-3.5) ft bgs	15.7		
			SB-223 (1-4) ft bgs	15.7		
			SB-230 (0-1) ft bgs	24.3 J		
			SB-231 (0-1) ft bgs	17.6		
			SB-232 (0-1) ft bgs	49.6 J		
			SB-232 (6-8) ft bgs	804 J		
			SB-233 (0-1) ft bgs	8.5 J		
			SB-234 (0-1) ft bgs	15.9		
			SB-235 (0.5-1.5) ft bgs	12.1		
			SB-235 (3-5) ft bgs	28.8		
			SB-236 (0-1) ft bgs	13.2		
			SB-237 (0-1) ft bgs	39.6		
			SB-237 (2-4) ft bgs	57.9		
			SB-238 (0-1) ft bgs	39.3		
			SB-238 (2-4) ft bgs	49.7/46.7		
			SB-240 (0-1) ft bgs	12.6 J		
			SB-241 (0-1) ft bgs	13.6 J		
			SB-243 (0-1) ft bgs	9.9 J		
			SB-244 (0-1) ft bgs	13.6 J		
			SB-244 (4-6) ft bgs	18.4 J		
			SB-246 (3-4) ft bgs	21.8		
			SB-254 (0-4) ft bgs	12.1		
			SB-303 (0-2) ft bgs	12.8		
			SB-304 (0-2) ft bgs	12.1		
			SB-306 (0-1) ft bgs	11.4		
			SB-308 (3-5) ft bgs	16.3		
			SB-308 (7.5-9.5) ft bgs	10.1		
			SB-310 (0-1) ft bgs	10.3		
			SB-311 (0-1) ft bgs	8.6		

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Mixed Residential/Commercial Area 2	Surface and Subsurface Soil	(Continued)	SB-312 (0-1) ft bgs	95.4		
			SB-2010 (0-1) ft bgs	12.5		
			SB-2010 (7-9) ft bgs	17.5		
			SB-2011 (3.4-4.75) ft bgs	15.7		
			SB-2013 (0-1) ft bgs	31.4		
			TP-339 (0-1) ft bgs	9		
			TP-340 (0-1) ft bgs	18.7		
			TP-340 (3-4) ft bgs	18.1		
			TP-342 (0-1) ft bgs	102		
			TP-342 (3.5-4) ft bgs	17.7		
			TP-343 (0-1) ft bgs	25.3		
			TP-343 (3-4) ft bgs	19.6		
			TP-344 (1-3) ft bgs	16.6		
			TP-344 (4-6) ft bgs	28.3		
Commercial Area 1	Surface Soil	7.361	SB-133 (0-1) ft bgs	10.0	4.628	5.8
			SS-103 (0-2) ft bgs	8.6		
			SS-105 (0-2) ft bgs	8.7		
			SS-106 (0-2) ft bgs	8.8 /8.9		
	Surface and Subsurface Soil	7.234	SB-133 (0-1) ft bgs	10.0	5.81	5.8
			SB-144 (7-9) ft bgs	10.6/5.0		
			SS-103 (0-2) ft bgs	8.6		
			SS-105 (0-2) ft bgs	8.7		
			SS-106 (0-2) ft bgs	8.8 /8.9		
Commercial Area 2	Surface Soil	9.947	TP-316 (0-1) ft bgs	16.4 J	5.742	5.8
			TP-325 (0-1) ft bgs	13.9 J		
			TP-321 (0-1) ft bgs	34.7		
	Surface and Subsurface Soil	13.33	SB-331 (8-10) ft bgs	46.9 J	5.757	5.8
			TP-316 (0-1) ft bgs	16.4 J		
			TP-324 (9-10) ft bgs	12.8 J/16.5 J		
			TP-325 (0-1) ft bgs	13.9 J		
			TP-325 (8-10) ft bgs	21.4 J		
			TP-321 (0-1) ft bgs	34.7		
Commercial Area 3	Surface Soil	12.24	SB-248 (0-1) ft bgs	8.5 J	NC	5.8
			SB-248 (0.5-1.5) ft bgs	9.4		
			TP-307 (0.5-1.5) ft bgs	16 /18		
			TP-305 (0.5-1.5) ft bgs	16		
	Surface and Subsurface Soil	9.59	SB-248 (0-1) ft bgs	8.5 J	5.575	5.8
			SB-248 (0.5-1.5) ft bgs	9.4		
			TP-307 (0.5-1.5) ft bgs	16 /18		
			TP-307 (2-3) ft bgs	13.0		
			TP-337 (2-4) ft bgs	13.3		
			TP-338 (8-10) ft bgs	15.6		
			TP-304 (5-7) ft bgs	11.1		
			TP-305 (0.5-1.5) ft bgs	16		

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Commercial Area 4	Surface Soil	19.38	MW-16 (0-2) ft bgs	8.9	5.723	5.8
			MW-17 (0-2) ft bgs	7.8/8.6		
			SB-201 (0-1) ft bgs	9.1 J		
			SB-202 (0-1) ft bgs	9.8 J		
			SB-203 (0-1) ft bgs	9.8 J		
			SB-204 (0-1) ft bgs	8.9 J		
			SB-245 (0-1) ft bgs	16.4 J		
			SB-249 (0-1) ft bgs	9.9 J		
			SB-263 (0-1) ft bgs	8.6		
			SB-264 (0-1) ft bgs	12.8		
			SB-265 (0-1) ft bgs	31.6		
			SB-267 (0-1) ft bgs	7.3		
			SB-268 (0-1) ft bgs	7		
			SB-270B (0-1) ft bgs	6.8 J		
			SB-274 (0-1) ft bgs	42.3		
			SB-275 (0-1) ft bgs	14.6		
			SB-276 (0-1) ft bgs	9.1		
			SB-277 (0-1) ft bgs	7.2		
			SB-278 (0-1) ft bgs	14.2		
			SB-279 (0-1) ft bgs	16.8		
			SB-280 (0-1) ft bgs	75.4		
			SB-281 (0-1) ft bgs	17.2		
			SB-282 (0-1) ft bgs	21.1		
			SB-283 (0-1) ft bgs	16.4		
			SB-284 (0-1) ft bgs	13.4		
			SB-285 (0-1) ft bgs	14.2		
			SB-287 (0-1) ft bgs	7.8		
			SB-289 (0-1) ft bgs	21.6 J		
			SB-290 (0-1) ft bgs	36.0 J		
			SB-293 (0-1) ft bgs	8.3 J		
			SB-294 (0-1) ft bgs	20.5		
			SB-295 (0-1) ft bgs	7.7		
			SB-298 (0-1) ft bgs	8.4 J		
			SB-299 (0-1) ft bgs	9.0 J		
			SB-2001 (0-1) ft bgs	7.3		
			SB-2002 (0-1) ft bgs	12.2 J		
			SB-2004 (0-1) ft bgs	8.6		
			SB-2005 (0-1) ft bgs	9		
			SB-2008 (0-1) ft bgs	10.4		
			SB-2012 (0-1) ft bgs	8.5		
			TP-202 (0.5-1.5) ft bgs	16.2/11.2		
			TP-341 (0.5-1.5) ft bgs	20.1		
Commercial Area 4	Surface and Subsurface Soil	16.68	BK5 (2.5-3) ft bgs	11	5.758	5.8
			NW Sidewall (1.5) ft bgs	60.8		
			NE Sidewall (2) ft bgs	65.6/49.4		
			SE Sidewall (1.5) ft bgs	50.7		
			SW Sidewall (2) ft bgs	31.5		
			MW-16 (0-2) ft bgs	8.9		
			MW-16 (8-10) ft bgs	11.6		
			MW-17 (8-10) ft bgs	29.6		
			MW-17 (0-2) ft bgs	7.8/8.6		

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Commercial Area 4	Surface and Subsurface Soil	(Continued)	SB-201 (0-1) ft bgs	9.1 J		
			SB-201 (2-4) ft bgs	13.3 J		
			SB-202 (0-1) ft bgs	9.8 J		
			SB-202 (2-4) ft bgs	20.0 J		
			SB-203 (0-1) ft bgs	9.8 J		
			SB-203 (2-4) ft bgs	17.6 J/13 J		
			SB-204 (0-1) ft bgs	8.9 J		
			SB-204 (2-4) ft bgs	10.5 J		
			SB-245 (0-1) ft bgs	16.4 J		
			SB-249 (0-1) ft bgs	9.9 J		
			SB-263 (0-1) ft bgs	8.6		
			SB-263 (3-5) ft bgs	10.4		
			SB-264 (0-1) ft bgs	12.8		
			SB-265 (0-1) ft bgs	31.6		
			SB-265 (2-4) ft bgs	15.4		
			SB-266 (1.4-2.4) ft bgs	7.5		
			SB-267 (0-1) ft bgs	7.3		
			SB-268 (0-1) ft bgs	7		
			SB-270B (0-1) ft bgs	6.8 J		
			SB-272 (1-3) ft bgs	10.1		
			SB-274 (0-1) ft bgs	42.3		
			SB-274 (2.5-4.5) ft bgs	9.5		
			SB-275 (0-1) ft bgs	14.6		
			SB-276 (0-1) ft bgs	9.1		
			SB-277 (0-1) ft bgs	7.2		
			SB-277 (3-5) ft bgs	8.8		
			SB-278 (0-1) ft bgs	14.2		
			SB-278 (3-5) ft bgs	7.6		
			SB-279 (0-1) ft bgs	16.8		
			SB-279 (3-5) ft bgs	4.9 J/21.8 J		
			SB-280 (0-1) ft bgs	75.4		
			SB-280 (3-5) ft bgs	12.5		
			SB-281 (0-1) ft bgs	17.2		
			SB-282 (0-1) ft bgs	21.1		
			SB-283 (0-1) ft bgs	16.4		
			SB-284 (0-1) ft bgs	13.4		
			SB-284 (2.5-4.5) ft bgs	10.6		
			SB-285 (0-1) ft bgs	14.2		
			SB-287 (0-1) ft bgs	7.8		
			SB-289 (0-1) ft bgs	21.6 J		
			SB-290 (0-1) ft bgs	36.0 J		
			SB-292 (3-5) ft bgs	11.4/7.7		
			SB-293 (0-1) ft bgs	8.3 J		
			SB-294 (0-1) ft bgs	20.5		
			SB-294 (3-5) ft bgs	7.7		
			SB-295 (0-1) ft bgs	7.7		
			SB-297 (1-2) ft bgs	10.7		
			SB-298 (0-1) ft bgs	8.4 J		
			SB-299 (0-1) ft bgs	9.0 J		
			SB-299 (4-5) ft bgs	15.8 J		
			SB-2001 (0-1) ft bgs	7.3		

TABLE 12

LOCATIONS REQUIRING REMOVAL TO MEET PART 201 STATEWIDE DEFAULT BACKGROUND LEVEL FOR ARSENIC
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Redevelopment Area	*Depth*	*Original EPC µg/g*	*Soil Locations Removed*		*Revised Arsenic EPC µg/g*	*Arsenic RBC µg/g*
			Location	*Arsenic Concentration µg/g*		
Commercial Area 4	Surface and Subsurface Soil	(Continued)	SB-2002 (0-1) ft bgs	12.2 J		
			SB-2004 (0-1) ft bgs	8.6		
			SB-2005 (0-1) ft bgs	9		
			SB-2005 (2.5-4.5) ft bgs	9		
			SB-2008 (0-1) ft bgs	10.4		
			SB-2009 (1-2) ft bgs	17.4 J		
			SB-2009 (5-7) ft bgs	7.6 J		
			SB-2012 (0-1) ft bgs	8.5		
			SB-2040 (1.5-2.5) ft bgs	52.8		
			SB-2041 (1-2) ft bgs	69.4		
			SB-2042 (2-5) ft bgs	8.42		
			SB-2043 (2.5-2.7) ft bgs	13.3		
			TP-17 (7-) ft bgs	10.1		
			TP-18 (8-) ft bgs	9.7		
			TP-19 (8-) ft bgs	8		
			TP-20 (8.5-) ft bgs	11.7		
			TP-201 (1-2) ft bgs	11.7		
			TP-202 (0.5-1.5) ft bgs	16.2/11.2		
			TP-202 (8-10) ft bgs	11.7		
			TP-341 (0.5-1.5) ft bgs	20.1		

Notes:
EPC - Exposure point concentration
J - Estimated
ft bgs - Feet below ground surface
RBC - Risk-based concentration

TABLE 13

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
TRESPASSER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption Factor, ABS_o	Dermal Absorption Factor, ABS_d	Trespasser Carcinogen TR Adolescent	Trespasser Non-Carcinogen THQ Adolescent	Soil Risk-Based Concentration RBC_{soil} (1)
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	(%/100)	(%/100)	(µg/g)	(µg/g)	(µg/g)
PCBs											
Total PCBs (10^{-4} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	6.21E+02	3.55E+01	35
Total PCBs (10^{-5} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	6.21E+01	3.55E+01	35
Total PCBs (10^{-6} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	6.21E+00	3.55E+01	6.2

Notes:

-- = Not Available

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) The basis for SA is assuming that potential exposed skin (U.S. EPA Exhibit C-1) consists of the face (425 cm^2), hands (700 cm^2), forearms (787 cm^2), lower legs (1610 cm^2) and feet (949 cm^2).

(3) The basis for the FT is the 50th percentile from Table 16-1, Recommended Values for Activity Factors - Time Outdoors (total).
The time spent outdoors for 11-16 years old of 100 min/day equates to 1.7 hours (100 min/60 min). The final FT is double the 50th percentile value or 3.4 hours.

(4) The basis for the EF is the 50th percentile from Table 16-1, Recommended Values for Activity Factors - Time Outdoors (total).
Ingestion/Inhalation: The time spent outdoors for 11-16 years old of 100 min/day out of a possible 365 days equates to 25 days (CT) (100 min/day x 365 days x 1 hour/60 min x 1 day/24 hours).
The final EF is double the 50th percentile value or 50 days.
Dermal: the time spent outdoors for 11-16 years old of 100 min/day out of a possible 245 days equates to 17 days (CT) (100 min/day x 365 days x 1 hour/60 min x 1 day/24 hours).
The final EF is double the 50th percentile value or 34 days.

(5) Trespasser is a 7 through 16 year old therefore the exposure duration is 10 years, based on U.S. EPA Region 4 (2000).

Trespasser Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS (Aroclor-1254)
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	
Ingestion Rate (mg/day) - adult	IR	100	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	4,471	U.S. EPA, 2004 (2)
Adherence Factor (mg/cm^2)	AF	0.2	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	Assumed	
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	3.4/24	U.S. EPA, 2008 (3)
Exposure Frequency (days/year) - ingestion/inhalation	EFa	50	see Section 2.2 of the Memorandum (4)
Exposure Frequency (days/year) - dermal	EFb	34	see Section 2.2 of the Memorandum (4)
Exposure Duration (years)	ED	10	U.S. EPA, 2000 (5)
Body Weight (kg)	BW	45	U.S. EPA, 2000
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	3,650	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{ED \times [(CSF \times IR \times EFa \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times EFb \times CF \times ABS_d)/BW + (URF \times EFa \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED \times [((1/RfD) \times IR \times EFa \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times EFb \times CF \times ABS_d)/BW + ((1/RfC) \times EFa \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2000: Region 4 Human Health Risk Assessment Bulletins – Supplement to RAGS, Section 4: Exposure Assessment, May.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

U.S. EPA, 2008: Child Specific Exposure Factors Handbook, September 2008.

TABLE 14

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
RECREATIONAL USER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Chemical of Potential Concern (COPC)	*CSF*		*URF*	*RfD*		*RfC*	*Oral Absorption Factor, ABS_o (%/100)*	*Dermal Absorption Factor, ABS_d (%/100)*	*Recreational User*		*Soil Risk-Based Concentration RBC_{soil} (1) (µg/g)*
	oral 1/(mg/kg-d)	*dermal 1/(mg/kg-d)*	*inhalation 1/(mg/m³)*	*oral (mg/kg-d)*	*dermal (mg/kg-d)*	*inhalation (mg/m³)*			*TR Child & Adult (µg/g)*	*THQ Child & Adult (µg/g)*	
PCBs											
Total PCBs (10^{-4} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	1.23E+02	2.12E+01	21
Total PCBs (10^{-5} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	1.23E+01	2.12E+01	12
Total PCBs (10^{-6} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	1.23E+00	2.12E+01	1.2

Notes:

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) The basis for the FT is based on ages 3-5 yrs from Table 16-1, Recommended Values for Activity Factors - Time Outdoors Playing on Dirt.

Recreational User Exposure Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS (Aroclor-1254)
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	
Age-Adjusted Ingestion Factor	IF	114	MDEQ, 2013
Age-Adjusted Dermal Factor	DF	353	MDEQ, 2013
Absorption Factor - Oral (%/100)	ABS_o	Assumed	
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Exposure Frequency (days/year) - ingestion/inhalation	EFa	70	see Section 2.2 of the Memorandum
Exposure Frequency (days/year) - dermal	EFb	48	see Section 2.2 of the Memorandum
Exposure Duration (years) - child & adult	ED	30	MDEQ, 2013
Fraction Time Exposed (hours/24 hours)	FT	2/24	U.S. EPA, 2008 (2)
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carc. (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - noncarc. (days) - child & adult	ATnc	10,950	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{[(CSF \times IF \times EFa \times CF \times ABS_o) + (CSF \times DF \times EFb \times CF \times ABS_d) + (URF \times FT \times EFa \times ED \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{[(((1/RfD) \times IF \times EFa \times CF \times ABS_o) + ((1/RfD) \times DF \times EFb \times CF \times ABS_d) + ((1/RfC) \times EFa \times ED \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

MDEQ, 2013. Operational Memoranda for the Remediation and Redevelopment Division: Part 201 Cleanup Criteria and Part 213 Risk Based Screening Levels. December 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

U.S. EPA, 2008: Child Specific Exposure Factors Handbook, September 2008.

TABLE 15

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
RESIDENTIAL ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Chemical of Potential Concern (COPC)	*CSF*		*URF*	*RfD*		*RfC*	*Oral Absorption Factor, ABS_o (%/100)*	*Dermal Absorption Factor, ABS_d (%/100)*	*Resident*		*Soil Risk-Based Concentration RBC_{soil} (1) (µg/g)*
	oral 1/(mg/kg-d)	*dermal 1/(mg/kg-d)*	*inhalation 1/(mg/m³)*	*oral (mg/kg-d)*	*dermal (mg/kg-d)*	*inhalation (mg/m³)*			*TR Child & Adult (µg/g)*	*THQ Child & Adult (µg/g)*	
PCBs											
Total PCBs (10^{-4} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	2.46E+01	4.21E+00	4.2
Total PCBs (10^{-5} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	2.46E+00	4.21E+00	2.5
Total PCBs (10^{-6} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	2.46E-01	4.21E+00	0.25

Notes:

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) The basis for the FT is based on ages 3-5 yrs from Table 16-1, Recommended Values for Activity Factors - Time Outdoors Playing on Dirt.

Resident Exposure Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS (Aroclor-1254)
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	
Age-Adjusted Ingestion Factor	IF	114	MDEQ, 2013
Age-Adjusted Dermal Factor	DF	353	MDEQ, 2013
Absorption Factor - Oral (%/100)	ABS_o	Assumed	
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Exposure Frequency (days/year) - ingestion/inhalation	EFa	350	see Section 2.2 of the Memorandum
Exposure Frequency (days/year) - dermal	EFb	245	see Section 2.2 of the Memorandum
Exposure Duration (years) - child & adult	ED	30	MDEQ, 2013
Fraction Time Exposed (hours/24 hours)	FT	2/24	U.S. EPA, 2008 (2)
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carc. (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - noncarc. (days) - child & adult	ATnc	10,950	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{[(CSF \times IF \times EFa \times CF \times ABS_o) + (CSF \times DF \times EFb \times CF \times ABS_d) + (URF \times FT \times EFa \times ED \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{[(((1/RfD) \times IF \times EFa \times CF \times ABS_o) + ((1/RfD) \times DF \times EFb \times CF \times ABS_d) + ((1/RfC) \times EFa \times ED \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

MDEQ, 2013. Operational Memoranda for the Remediation and Redevelopment Division: Part 201 Cleanup Criteria and Part 213 Risk Based Screening Levels. December 2013.

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

U.S. EPA, 2008: Child Specific Exposure Factors Handbook, September 2008.

TABLE 16

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
COMMERCIAL WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption	Dermal Absorption	Commercial Worker		Soil Risk-Based
									Carcinogen	Non-Carcinogen	Concentration
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	Factor, ABS_o (%/100)	Factor, ABS_d (%/100)	TR Adult (µg/g)	THQ Adult (µg/g)	RBC_{soil} (1) (µg/g)
PCBs											
Total PCBs (10^{-4} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.00E+00	1.4E-01	9.11E+01	1.30E+01	13
Total PCBs (10^{-5} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.00E+00	1.4E-01	9.11E+00	1.30E+01	9.1
Total PCBs (10^{-6} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.00E+00	1.4E-01	9.11E-01	1.30E+01	0.91

Notes:

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Professional Judgment; assumed 8 hour work day.

Commercial Worker Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS (Aroclor-1254)
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	
Ingestion Rate (mg/day) - adult	IR	100	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	3,300	U.S. EPA, 2004
Adherence Factor (mg/cm^2)	AF	0.2	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	Assumed	
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	8/24	Professional Judgement (2)
Exposure Frequency (days/year) - ingestion/inhalation	EFa	245	see Section 2.2 of the Memorandum
Exposure Frequency (days/year) - dermal	EFb	160	see Section 2.2 of the Memorandum
Exposure Duration (years)	ED	25	U.S. EPA, 2004
Body Weight (kg)	BW	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	9,125	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.36E+09	U.S. EPA, 2002

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{ED \times [(CSF \times IR \times EFa \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times EFb \times CF \times ABS_d)/BW + (URF \times EFa \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{ED \times [((1/RfD) \times IR \times EFa \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times EFb \times CF \times ABS_d)/BW + ((1/RfC) \times EFa \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

TABLE 17

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
UTILITY WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption Factor, ABS_o	Dermal Absorption Factor, ABS_d	Utility Worker Carcinogen TR	Utility Worker Non-Carcinogen THQ	Soil Risk-Based Concentration
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	(%/100)	(%/100)	Adult (µg/g)	Adult (µg/g)	RBC_{soil} (1) (µg/g)
PCBs											
Total PCBs (10^{-4} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	1.59E+03	9.09E+00	9.1
Total PCBs (10^{-5} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	1.59E+02	9.09E+00	9.1
Total PCBs (10^{-6} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	1.59E+01	9.09E+00	9.1

Notes:

-- = Not Available

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Professional Judgement; assumed 8 hour work day.

(3) Professional Judgement; assumes 5 days/week for 6 months or 120 days/year.

(4) Professional Judgement; assumes utility maintenance activities occurs within a one year time period.

Utility Worker Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS (Aroclor-1254)
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	
Ingestion Rate (mg/day) - adult	IR	330	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	3,300	U.S. EPA, 2004
Adherence Factor (mg/cm^2)	AF	0.3	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	Assumed	
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	8/24	Professional Judgement (2)
Exposure Frequency (days/year)	EF	120	Professional Judgement (3)
Exposure Duration (years)	ED	1	Professional Judgement (4)
Body Weight (kg)	BW	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	365	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	2.39E+09	U.S. EPA, 2002; See Table 1

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times CF \times ABS_d)/BW + (URF \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times CF \times ABS_d)/BW + ((1/RfC) \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

TABLE 18

DERIVATION OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
CONSTRUCTION WORKER ORAL, DERMAL, AND INHALATION EXPOSURE
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

	CSF		URF	RfD		RfC	Oral Absorption	Dermal Absorption	Construction Worker Carcinogen	Construction Worker Non-Carcinogen	Soil Risk-Based
Chemical of Potential Concern	oral 1/(mg/kg-d)	dermal 1/(mg/kg-d)	inhalation 1/(mg/m^3)	oral (mg/kg-d)	dermal (mg/kg-d)	inhalation (mg/m^3)	Factor, ABS$_o$ (%/100)	Factor, ABS$_d$ (%/100)	TR Adult (µg/g)	THQ Adult (µg/g)	Concentration RBC$_{soil}$ (1) (µg/g)
PCBs											
Total PCBs (10^{-4} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	3.81E+02	5.45E+01	55
Total PCBs (10^{-5} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	3.81E+01	5.45E+01	38
Total PCBs (10^{-6} cancer risk)	2.00E+00	2.00E+00	5.70E-01	2.00E-05	2.00E-05	--	1.0E+00	1.4E-01	3.81E+00	5.45E+01	3.8

Notes:

-- = Not Available

NV = No Value

(1) The selected RBC is the lower of the carcinogenic-based concentration and the non-carcinogenic-based concentration.

(2) Professional Judgement; assumed 8 hour work day.

(3) Professional Judgement; assumes 5 days/week for 1 month or 20 days/year.

Construction Worker Assumptions

Risk-Based Concentration in Soil (µg/g)	RBC_{soil}	calculated	
Target Cancer Risk (unitless)	TR	1.0E-04	
Target Cancer Risk (unitless)	TR	1.0E-05	
Target Cancer Risk (unitless)	TR	1.0E-06	
Target Hazard Quotient (unitless)	THQ	1.0	
Cancer Slope Factor (per mg/kg-day)	CSF	chemical-specific	IRIS
Reference Dose (mg/kg-day)	RfD	chemical-specific	IRIS (Aroclor-1254)
Unit Risk Factor (per mg/m^3)	URF	chemical-specific	IRIS
Reference Concentration (mg/m^3)	RfC	chemical-specific	
Ingestion Rate (mg/day) - adult	IR	330	U.S. EPA, 2002
Surface Area Exposed (cm^2/day)	SA	3,300	U.S. EPA, 2004
Adherence Factor (mg/cm^2)	AF	0.3	U.S. EPA, 2004
Absorption Factor - Oral (%/100)	ABS_o	Assumed	
Absorption Factor - Dermal (%/100)	ABS_d	chemical-specific	U.S. EPA, 2004
Fraction Time Exposed (hours/24 hours)	FT	8/24	Professional Judgement (2)
Exposure Frequency (days/year)	EF	20	Professional Judgement (3)
Exposure Duration (years)	ED	25	U.S. EPA, 2004
Body Weight (kg)	BW	70	U.S. EPA, 2002
Conversion Factor (kg/mg)	CF	1.0E-06	
Averaging Time - carcinogenic (days)	ATc	25,550	U.S. EPA, 1989
Averaging Time - non-carcinogenic (days)	ATnc	9,125	U.S. EPA, 1989
Particulate Emission Factor (m^3/kg)	PEF	1.59E+07	U.S. EPA, 2002; see Table 2

Exposure Equations

Carcinogenic Endpoints:

$$RBC_{soil} = \frac{TR \times ATc}{EF \times ED \times [(CSF \times IR \times CF \times ABS_o)/BW + (CSF \times SA \times AF \times CF \times ABS_d)/BW + (URF \times FT \times (1/PEF))]}$$

Non-Carcinogenic Endpoints:

$$RBC_{soil} = \frac{THQ \times ATnc}{EF \times ED \times [((1/RfD) \times IR \times CF \times ABS_o)/BW + ((1/RfD) \times SA \times AF \times CF \times ABS_d)/BW + ((1/RfC) \times FT \times (1/PEF))]}$$

References:

IRIS, Integrated Risk Information System (IRIS) Database, (http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showSubstanceList).

U.S. EPA, 1989: Risk Assessment Guidance for Superfund (RAGS): Volume 1 – Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989.

U.S. EPA, 2002: Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002.

U.S. EPA, 2004: Risk Assessment Guidance for Superfund (RAGS):Volume 1 - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), EPA/540/R/99/005, July 2004.

TABLE 19

SUMMARY OF RISK-BASED CONCENTRATIONS (RBCs) FOR POLYCHLORINATED BIPHENYLS IN SOIL
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Chemical of Potential Concern (COPC)	*Units*	*Risk-Based Concentration for Soil, RBC_{soil}*						*Minimum RBC_{soil}*		
		Trespasser	*Recreational User*	*Resident*	*Commercial Worker*	*Utility Worker*	*Construction Worker*	*Residential (1)*	*Commercial (2)*	*Commercial+Recreational (3)*
TARGET CANCER RISK = 1.0×10^{-4}; TARGET HAZARD QUOTIENT = 1.0										
Total PCBs	µg/g	35	21	4.2	13	9.1	55	4.2	9.1	9.1
TARGET CANCER RISK = 1.0×10^{-5}; TARGET HAZARD QUOTIENT = 1.0										
Total PCBs	µg/g	35	12	2.5	9.1	9.1	38	2.5	9.1	9.1
TARGET CANCER RISK = 1.0×10^{-6}; TARGET HAZARD QUOTIENT = 1.0										
Total PCBs	µg/g	6.2	1.2	0.25	0.91	9.1	3.8	0.25	0.91	0.91

Notes:
(1) RBC_{soil} for the residential areas include all receptors.
(2) RBC_{soil} for the commercial areas include all receptors, except residents and recreational users.
(3) RBC_{soil} for the commercial+recreational areas include all receptors, except residents.